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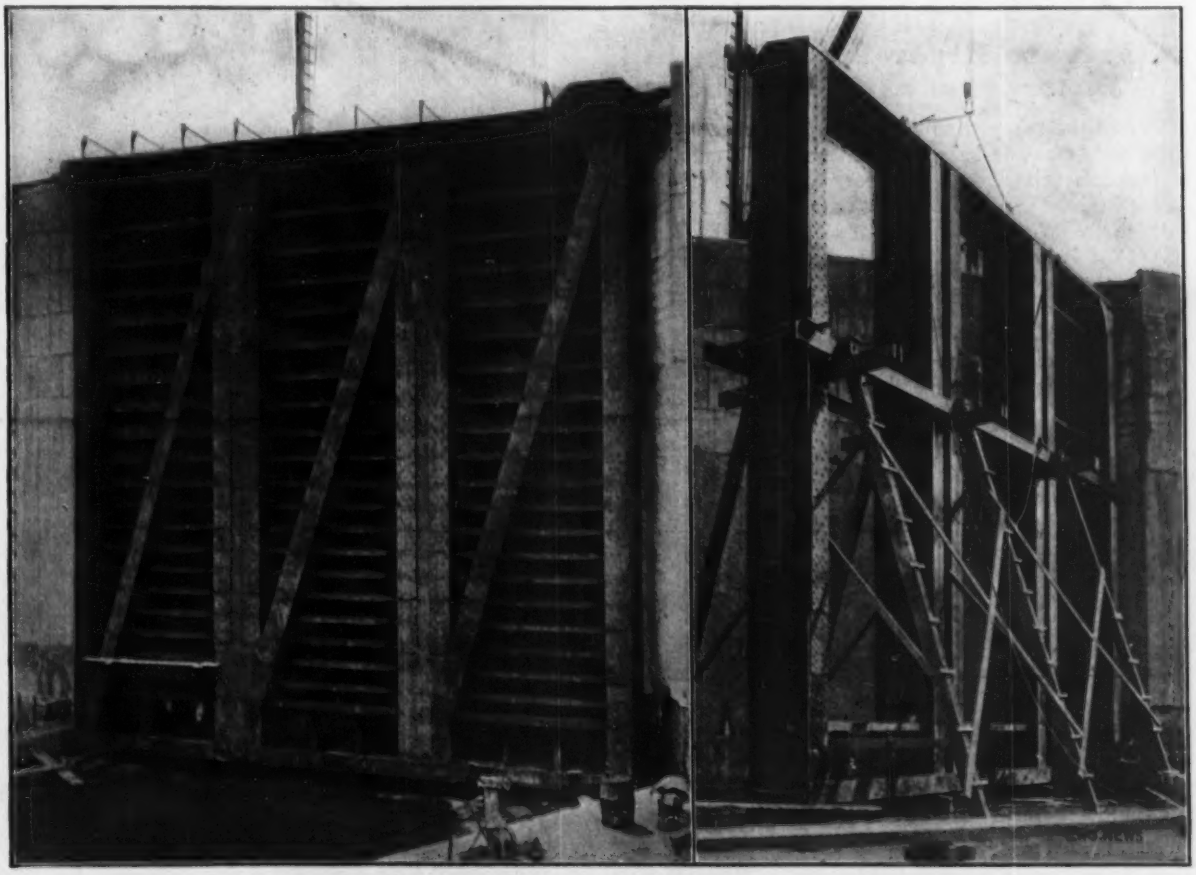
Vertical-Framed Lock-Gates, St. Paul-Minneapolis Dam

A rarely used form of lock-gate has been adopted for the 31-ft.-lift lock of the new government dam across the Mississippi River at Minnehaha Park, between St. Paul and Minneapolis. The gates do not miter except at the extreme top, where thrust blocks are fitted to the meeting ends of the gates and to the hinge joints; the rest of the gate pressure, or two-thirds of the total, is carried by direct bearing of the gate leaves against the sill. Thus the body of the gate leaf must transfer the water pressure vertically to the sill girder at the bottom and the miter or arch girder at the top, instead of horizontally to hinge joint and miter joint. This gives the type its name—vertical-framed gate.

The lock is 80 ft. wide by 350 ft. long between gate quoins, or about 365 ft. long from the upper edge of lower gate-recess to lift wall near upper gate. Each leaf is 47 ft. 3 in. long by 49 ft. 3 in. high over all, which brings its top about 39 ft. above the probable low-water level in the lower reach, and about 2 ft. below the estimated extreme flood level of the pool above (when a 10-ft. depth of water flows over the dam). The two gates, designed for maximum stresses of 12,000 lb. per sq.in., weigh about 300 tons. They were built by the Independent Bridge Co., of Pittsburgh, Penn., and erected by the U. S. Engineer Office, St. Paul, which is constructing the dam and lock on force-account. The cost of material and erection of the gates was unusually low, on account of the simplicity of design and the low stresses resulting from the type of framing.



VERTICAL-FRAMED LOWER GATES OF NEW GOVERNMENT LOCK IN MISSISSIPPI RIVER NEAR MINNEHAHA CREEK

(Left-hand view shows downstream side of one leaf, practically completed. Right-hand view shows this leaf when only the main frame was erected.)

In this type of gate, only one-third the arch-thrust of the mitering type of gate has to be carried, since two-thirds the water pressure goes direct to the sill. As height and width of the gate are practically equal, the lengths of

main beams would be about the same whether vertical or horizontal. However, the arrangement of the beams is somewhat more economical in the vertical-framed type, as it is possible to use vertical main beams and horizontal secondary beams, arranged with sole regard to economy of metal. Further, the thrust being reduced by two-thirds, the abutment or miter castings are reduced correspondingly, in weight and cost.

Two views herewith shows the gates during erection. They are now completed except for the water-stop members at hinge and miter joints, and the operating mechanism. The plating of the gates is at mid-depth of the girders, the secondary framing beams being shallow enough to permit this. This arrangement was utilized to reduce the uplift when the lock is full, to an amount corresponding to half the ground-plan area of the gate, which is enough to nearly balance the weight of the steel.

Lieut.-Col. Charles L. Potter is in charge of the construction of the lock and dam. Geo. W. Freeman, Assistant Engineer, designed the structures and is carrying out the construction work as superintendent.

A Private River-Straightening Enterprise at Cleveland

One of the many windings of the Cuyahoga River at Cleveland, Ohio, is being straightened by a cutoff, but private enterprise is doing the work for its own interests, on the basis of plans worked out and approved by public authorities. Work was begun last season, and by the end of 1914 it is expected to be so far along that water will flow in the cutoff channel. Filling the old channel will probably require the 1915 season.

The sketch map, Fig. 1, shows the location of the work now in hand (hatched portion near southerly end), and several projects proposed (more or less definitely) for the near future. A cutoff passing under the easterly part of the new Detroit-Superior viaduct was projected but has been abandoned; instead there may be cutoffs both upstream and downstream of the viaduct, intersecting the present channel at the viaduct.

The valley of the Cuyahoga for three miles below the Denison-Harvard viaduct forms a broad bottom, over a mile wide. In the upper half of this stretch the present straightening enterprise is located. It will divide the width of the valley into almost equal strips, and will give to the new plant of the Otis Steel Co., west of the new channel, an unbroken width of ground-area fronting the full length along the new channel.

The construction of the cutoff came about through the acquisition of the entire width of the bottoms by Cleveland capitalists forming the Cuyahoga Valley Realty Co., and the sale by them of the westerly half to the Otis Steel Co. The project for the cutoff was worked out by the City of Cleveland, however, through its River and Harbor Commission and the City Engineer's office (Robert Hoffmann, City Engineer; E. B. Thomas, Assistant Engineer in charge of river and harbor). The U. S. War Department gave its approval to the proposed work in January, 1913. The central part of the work is being done under direction of the Otis Steel Co., and is paid for by this company and the realty company. About one-third of the total length of the new channel, the upstream and downstream ends, will have to be constructed by the city (alone or in coöperation with private interests) on account of land-ownership difficulties and other reasons.

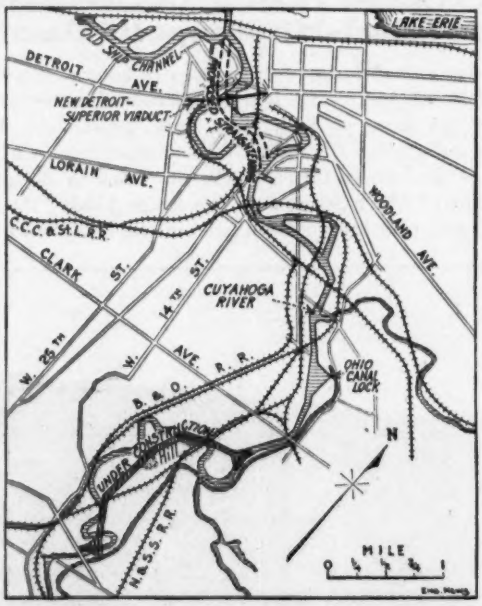
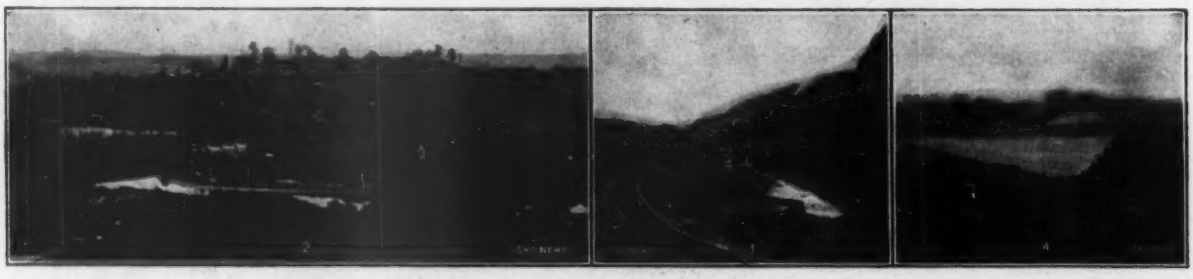


FIG. 1. CUYAHOGA RIVER, CLEVELAND, O., SHOWING STRAIGHTENING PROPOSED AND IN PROGRESS



FIGS. 2-4. RIVER-STRAIGHTENING WORK IN PROGRESS

(Fig. 2. Looking toward hill to be removed on line of new channel. Fig. 3. Steam shovel at work. Fig. 4. Fill made from steam-shovel excavation.)

The location of the new channel cuts right across a hill rising some 100 ft. out of the bottom land. The first construction work was making the cut through this hill. This was steam-shovel work, the spoil, moved by cars, being used to fill low-lying ground near-by. The views, Figs. 2 to 4, show the shovel work in progress, and indicate the characters of the valley generally.

Dredging was begun in a small way last season, not

primarily as regular work on the cutoff but for the purpose of obtaining sand, outside parties doing the dredging at their own cost. This was not carried very far, however, because of too much clay in the soil

Dredging by the contractor for the cutoff is to begin shortly, with equipment specially built for the job. Expectations are that it will progress fast enough to open the channel through the hill before 1915. The dredge is a suction dredge with electric-driven pumps, set in a light-draft hull, and supplied with power by pole-line. The American Shipbuilding Works, Cleveland, built the hull, and the Marion Steam Shovel Co. furnished and placed the machinery.

P. T. McCourt is contractor for the cutoff. The total cost of the work will be about $1,000,000.

A Safety Fire Escape*

The fire escape shown in the accompanying sketches has been installed in the printery of the Travelers' Insurance Co., at Hartford, Conn. Its distinguishing feature is a design whereby the lower flight is normally in a horizontal position well up from the ground, but is automatically swung to the ground by a person coming down the flight next above. The general outline is given in Fig. 1 and the details of the releasing mechanism in Fig. 2.

The projection at the free end of the stairway (Figs. 1-2) rests upon a lever, when the stairway is in the horizontal position (as shown by the dotted lines in Fig. 1), which lever is itself supported by a bracket and by bolts

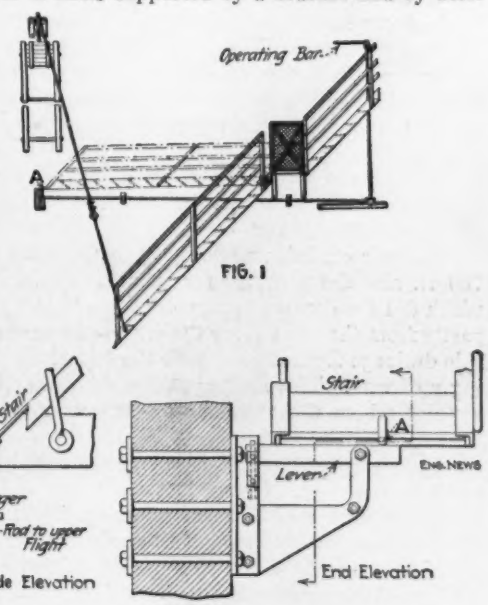


FIG. 1

FIG. 2

FIG. 1. OPERATION OF THE SWINGING STAIRWAY
FIG. 2. DETAILS OF RELEASING MECHANISM

passing through the wall. Heavy plates are used between the nuts and the inside of the wall. A trigger fulcrumed to the bracket engages the lever and thus supports the stairway in the horizontal position. The lower end of the trigger is pivoted to a horizontal rod, which passes along the side of the wall through supports to a box, to which a vertical rod is connected, through a cam within the box. This vertical rod passes between the wall and the stairway to a point about half-way up the upper flight; the brackets are bolted to the wall to support this rod. The upper end of the rod is connected to the operating bar, which normally extends across the stairway.

In case of fire, a person coming down the stairway pushes against the operating bar and swings it against the wall. This causes the vertical rod to turn the cam in the box so that it pushes the horizontal rod and releases the lever by operating the trigger. The hinged stairway now being unsupported, tilts the lever and swings to the ground; the counterweight is purposely made too light to support the entire weight of the stairway. These operations take place before the person who moves these levers has reached the lower balcony; and upon reaching this balcony, therefore, he has a continuous solid stairway before him.

In moving from the horizontal to the inclined position, the stairway has a shearing action. The wire-mesh guard, shown in the upper diagram, is therefore provided to prevent accidents.

*Abstracted from the "Travelers Standard" for May.

An Engineering Competition for Students

A competition in the solution of engineering problems, open to students in technical colleges, has been recently completed by the Engineers Society of Western Pennsylvania, under the direction of its committee on Engineering Education. The results have been so satisfactory that a second competition will be arranged for 1914-15.

One problem was offered in each of the fields of civil, mechanical and electrical engineering. Copies were sent Oct. 15, to deans of engineering schools in which students wished to compete, four months actual work being allowed and a copy given to each competing student. An explicit statement of sources of information and procedure accompanied each. Contestants were third- or fourth-year men working alone or in pairs; solutions represented no assistance beyond the printed data and "such general discussion as was consistent with honorable competition." The prizes were a first, second and third "certificate of award" and "honorable mention," in each class. The judges were (I) Civil Engineering; Paul L. Wolfel, Chief Engineer, McClintic-Marshall Construction Co.; Richard Khuen, Jr., General Manager of Erection, American Bridge Co.: (II) Mechanical Engineering; O. P. Hood, Chief Mechanical Engineer, U. S. Bureau of Mines; F. C. Biggert, Jr., Chief Engineer, United Engineering & Foundry Co.: (III) Electrical Engineering; William Hoopes, Electrical Engineer, Aluminum Co., of America; W. Edgar Reed, Consulting Engineer.

The civil-engineering problem was the design of a country highway bridge—given survey notes, unit prices, etc. The mechanical-engineering task was the design of a grinding machine taking castings up to 12 in. wide. The problem in electrical engineering was to design a system by which 30,000-volt alternating current was transported and converted to 550-volt direct current.

Those receiving the first awards were: In civil engineering H. W. Terhune and R. W. Hill, Tufts College, Boston; in mechanical engineering, F. C. Eastman and A. D. Stewart; in electrical engineering J. R. Lainbach, Georgian School of Technology.

Two Recent Water-Power Plant Accidents

Two accidents of rather unusual character have recently occurred at water-power plants located in the State of New York. In one the ashlar face of a 14-year old masonry dam slid off for the whole length of the dam under conditions not obviously abnormal; in the other a moderate flood was diverted, mainly by an incompleted culvert, in an undesigned direction with the result that about 700 ft. of new macadam roadway was destroyed by a serious washout that also undermined the foundations of 150 ft. of 7-ft. steel penstock.

Dam Face Failure

The dam affected is located at Hannawa Falls, St. Lawrence County, New York, and forms the storage reservoir for the Hannawa Falls Water Power Co. On the morning of Mar. 1, the Potsdam sandstone ashlar facing

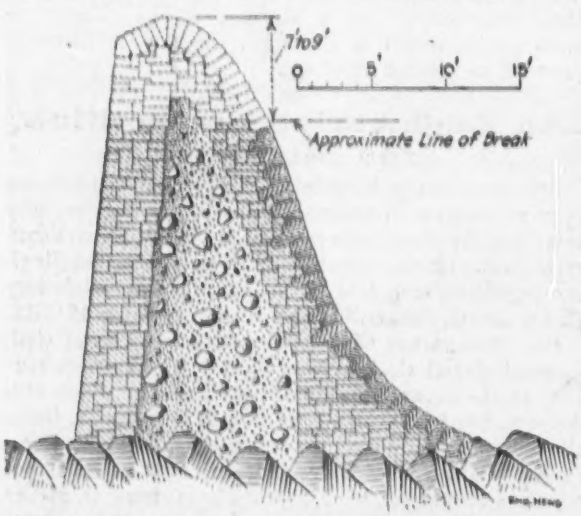


Fig. 1. Cross-Section through Hannawa Falls Dam, Showing Break in Ashlar Facing

on the downstream side of the crest of the dam slid and caved off for a distance of about 7 to 9 ft. below the crest and throughout practically the entire length of the crest of the dam. This dam was constructed in 1900, having a cross-section as shown in Fig. 1,* the central core being concrete. The upstream rubble facing was injured to some extent but not to as great a depth as on the downstream side. The line of fracture occurred at the plane of contact between the cyclopean concrete core and the masonry facing. The concrete core remained intact.

The flow of the stream was relatively small at the time, being reported as follows at the nearest gaging station at Piercefield: Feb. 27, 547 cu.ft. per sec.; Feb. 28, 417 cu. ft. per sec.; Mar. 1, 193 cu.ft. per sec.; Mar. 2, 513 cu. ft. per sec.

The drainage area at Piercefield is 723 sq.mi. and that of Hannawa Falls about 1100 sq.mi. The dam formed a pond of about 200 acres area, which was covered with thick ice at the time of the accident to the dam. Owing to the low stage of the stream, the water was quickly drawn down below the level of the injured portion of the dam.

Various theories have been offered to explain the injury to this dam; including, first, direct ice pressure against the ashlar coping above the level of the concrete; second, injury to or disintegration of the ashlar masonry by moisture and frost. Potsdam sandstone is a comparatively soft porous material. In view of the fluctuation in water-level in the pond and the manner of the dam failing without injury to the concrete core or upstream face comparable to the injury of the downstream face, it appears that no theory yet5 advanced is satisfactory.

Road and Penstock Washout

The washout described below occurred during the last part of April near another water-power plant in the northern part of the state. The plant in question has a solid masonry dam forming a pond which is crossed by a highway about 50 ft. above the dam. The highway, after crossing this bridge, turns away from the downstream face of the dam and runs along a sidehill, at the bottom of which is the gorge of the dammed stream. Between this gorge and the highway there was a 7-ft. steel penstock, built in a trench excavated in the loose sand and gravel which overlies the rock.

The results of the washout are shown in the view in Fig. 2, which is from a photograph taken looking along the sidehill toward the dam in the right background. The washout, alongside of the road and directly under the destroyed penstock, is in the center of the view and the highway is shown at the extreme upper left.

The flood was a sudden one, arising from the melting of the snow in the woods after a rapid rise in temperature. Although the flood was of unusual volume, the discharge over the dam did not reach the spillway capacity. The immediate cause of the washout was water following down the penstock trench to a gulley, where it accumulated and broke through the bank into the gorge below. The loose soft material—sand, gravel, and sawmill waste—was easily eroded, undermining the highway for about 700 ft. and the penstock for about 170 ft. The water which did the damage apparently came from two sources, partly from the pond above the dam and partly from hillside drainage from the slopes to the left of the dam looking upstream. This drainage came down the highway to a point where the macadam road turned to cross the bridge above the dam. Near this turn in the macadam road was a culvert intended to carry this hillside drainage into the river. Owing to the lateness of the season when the work was finished, no channel had been provided to take the discharge of this culvert after it crossed the highway, and the flow through the culvert entered directly into the penstock channel.

At the time the water in the pond reached a sufficiently high stage to flow over the highway, the water in the pond was rising very slowly and in fact did not rise to any appreciable height after the washout started. Damage from this source could apparently have been avoided by the simple expedient of throwing up a loose sand embankment 40 or 50 ft. long and not more than one foot high along the highway. However, the only persons present were the operatives of the power plant who, seeing the danger, devoted their entire attention to closing the headgates. As a result, the water was drained out

*Taken from a paper "Water Power Development at Hannawa Falls," by W. C. Johnson, Trans. Am. Soc. M. E., Vol. 23, 1902.

of the penstock before any portion of the penstock was undermined.

The injured penstock was taken apart in sections; sent to the nearest boiler works, rolled into shape and is at this time being put back into position.

The drainage area above the dam is 110 sq.mi. There are numerous lakes and a broad flat valley with deep sand deposits which acts as a very extensive natural regulator, so that in spite of the precipitous rock slopes surrounding the basin, the runoff is very regular. The maximum discharge of the stream at the time of the accident is estimated to have been in the neighborhood of 1500 cu.ft. per sec. Judging by the reported conditions and from the cross-section of the channel where the water flowed over the highway, the quantity of water passing around the end of the dam apparently could not at any time have exceeded 100 cu.ft. per sec. Inasmuch as this channel was greatly increased in area by the washing out of a section of the highway, it appears probable that the quantity of water which flowed around the end of the dam did not at any time exceed 40 to 60 cu.ft. per sec. The fact that many thousand yards of earth were removed during the period of a few hours by this small quantity of water is due to the extremely loose character of the material excavated. The penstock was constructed in a trench excavated in the loose sand and gravel which overlies the rock. The work was completed late last fall and as excavated material had frozen the trench was not refilled.

FIG. 2. WASHOUT OF HIGHWAY AND 7-FT. STEEL PENSTOCK DUE TO BYPASSED OVERFLOW FROM A DAM AND TO SIDE-HILL RUNOFF

Cleaning and Repairing the Sudbury Masonry Aqueduct of the Metropolitan Water Works, Boston, Mass., is described in the recently issued annual report of the Metropolitan Water and Sewerage Board as follows:

Two gangs of men were employed one beginning at each end of the section to be cleaned and working toward each other. One gang used water and hand brooms in cleaning the sides and top of the aqueduct, a wagon with a tank body being used when cleaning the top. The second gang made use of a gasoline power sprayer, by which water under 200 lb. pressure was discharged against the interior surface of the aqueduct. This method proved more efficient, more economical and quicker than the hand method. The cleaning of the bottom was done with push brooms operated by hand. The ironwork of the gates and stop-plank grooves in the screen and terminal chambers was thoroughly scraped, dried by the use of torches, and painted with two coats of red lead and oil. When the aqueduct was first emptied it was found that water was flowing in through small crevices in the brick and concrete, the greater number of which were where the aqueduct is generally in tunnel. In this section 1400 leaks in the tunnel lining were repaired by driving the calking wedge lead, tea lead or lead wool into the joints. The cost of cleaning and repairing this section of the aqueduct was as follows:

	Labor	Materials	Total
Cleaning aqueduct	$270.05	$4.58	$274.63
Cleaning and painting ironwork	121.00	21.27	142.27
Repairing leaks in masonry	96.75	37.10	133.85
	$487.80	$62.95	$550.75

General Observations on Street Pavements of European Cities*

By Henry Welles Durham†

SYNOPSIS—In the summer of 1913 Mr. Durham was commissioned by the Mayor of New York City to attend the Third International Road Congress at London, and to take several months to study European pavements, which from time to time had been compared with New York City pavements, to the disadvantage of the latter, by the popular press. In this article Mr. Durham summarizes European paving practice in such a way that municipal engineers may know just what foreign practice is and just what results have been attained.

Foundation

Up to the middle of the last century, the pavement consisting of stone blocks laid directly on the ground of various substructures required by conditions which have arisen within the past 25 years, there is universal agreement among those in control of city highways that concrete foundations are indispensable when constructing new pavements in important thoroughfares.

Such foundations are essential in almost all streets of American cities, which, in addition to having been disturbed for subsurface construction, are very largely on regraded ground; whereas many of the older cities of Europe have streets which have occupied their present position for hundreds of years; and where, as can be seen in Hamburg in the case of a street not subject to frequent opening, the stone block surface can be satisfactorily maintained on the original hard soil underlying it.

Fig. 1. Method of Construction, a 12-In. Concrete Foundation for Soft-Wood Block; All Hand Mixing; Gracechurch St., London

Fig. 2. Finishing a Concrete Surface for Hard-Wood Blocks; Rotterdam

surface of the street was considered satisfactory in all European cities. At the present time, such a surface is used on a great part of the streets in every European city.

It was not until the year 1890, when was first commenced the placing of electric wires in underground conduits instead of on overhead poles, followed within a few years by the introduction of motor-driven vehicles in large numbers, that the necessity for a rigid foundation under a repairable wearing surface for city streets assumed great importance.

At the present time, due to the great increase in weight of traffic on the streets of cities of the first class, and to the frequent necessity for opening them for the laying Subsurface conditions in London, on the other hand, due to the nature of the underlying material, are such as to justify the authorities there in demanding the heaviest foundations to be found anywhere, 12 in. being used in the central part of the city. But even in London there were found in the outlying residence districts a large proportion of satisfactorily surfaced streets without an artificial foundation.

Great differences exist as to the thickness of concrete foundation where used, and the proportioning of materials composing it. Concrete 4 in. thick is regarded as satisfactory in many places, even in such an important city as Brussels. Probably the standard thickness at the present time is from 6 to 8 in. The proportions in which foundation concrete is mixed vary greatly. For purposes of comparison, Table I shows some of the various proportions used abroad:

*Abstract of Chapter VII of the forthcoming report on "Street Paving and Maintenance in European Cities," to the Mayor of the City of New York.

†Chief Engineer, Bureau of Highways, Borough of Manhattan, New York City.

TABLE I

	Cement	Fine Aggregate	Coarse Aggregate	
London:				
City and Westminster	1	..	6	Thames ballast—unscreened river gravel
Lewisham	1	..	7	Thames ballast—unscreened river gravel
Battersea	1	3 sand	5	clean gravel
Liverpool	1	6 crushed slag	3	broken stone, 3-in. gage
Paris	1	3¾ sand	7½	stone or gravel
Berlin and Charlottenburg	1	..	8	fine gravel and sand
Hamburg	1	..	7	unscreened river gravel
Vienna	1	3 sand	5	gravel

The concrete is commonly laid between forms set transversely to the axis of the street at intervals of about 15 ft., materials being turned over on a mixing board between these forms directly into place. Final finish to the surface is then obtained by drawing a straight-edge across the width of the street, the concrete being mixed wet enough so that finer material flushes to the surface and produces a fairly smooth finish under the straight-edge.

Where this method is not followed, the forms are placed longitudinally and the finished surface obtained by drawing along on them a template formed to the proper transverse section.

Where wood pavement is to be laid, particular attention is given to obtaining an accurate, smooth surface, and a certain amount of hand-smoothing is sometimes employed. It was noted in London and in other cities,

FIG. 3. LARGE 18x24-IN. STONE BLOCKS IN FRONT OF CATHEDRAL AT MILAN

FIG. 4. LARGE STONE BLOCKS, 8x10 IN., LAID ON SAND FOUNDATION, VIENNA

FIG. 5. GRANITE-BLOCK PAVEMENT, LIVERPOOL

TYPICAL STONE-BLOCK PAVEMENTS IN EUROPEAN CITIES

The work of concrete mixing is done almost entirely by hand, although concrete-mixing machinery has been introduced in Germany to a small extent. The subfoundation is generally rough graded, with about the same accuracy prevalent in New York City, but it is more usual to finish the concrete surface smooth.

however, that by employing the method of accurately setting transverse strips to the surface grade on narrow widths of concrete, and then drawing a straight-edge or a screed along on these adjacent strips (between which the work of mixing and placing was carried on), that a sufficiently smooth finish was obtained with very little surfacing. For asphalt and granite pavement, it is not attempted to obtain such smooth results on the foundation surface; but usually a more accurate surface is obtained on all classes of work than in this country, though it is at the sacrifice of speed. The quality of the concrete is in no case superior to that being produced at the present time in New York City; and frequently it is inferior.

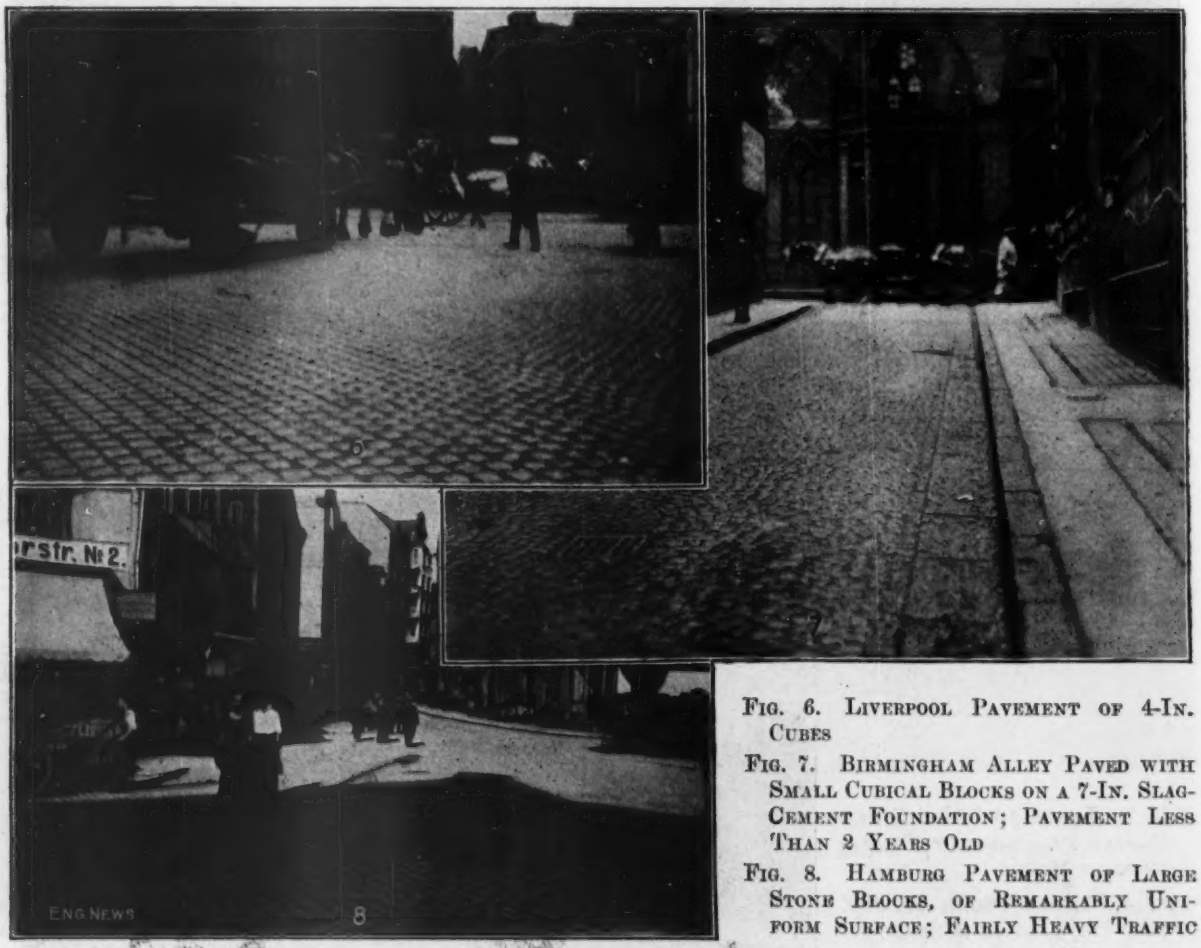


FIG. 6. LIVERPOOL PAVEMENT OF 4-IN. CUBES

FIG. 7. BIRMINGHAM ALLEY PAVED WITH SMALL CUBICAL BLOCKS ON A 7-IN. SLAG-CEMENT FOUNDATION; PAVEMENT LESS THAN 2 YEARS OLD

FIG. 8. HAMBURG PAVEMENT OF LARGE STONE BLOCKS, OF REMARKABLY UNIFORM SURFACE; FAIRLY HEAVY TRAFFIC

TYPICAL GRANITE-BLOCK PAVEMENTS IN EUROPE

STONE PAVEMENTS

Perhaps the most frequently used block in Europe is the squared block having generally cubical dimensions, of the type known in this country as "Belgian" block. The blocks are usually laid without foundation, but their regular shape permits of joints not exceeding 1 in. in width and a surface much smoother under wheel traffic than that of the old-style cobble.

Another variation, but of the same class, is the type of large slab block pavement employed in Italy and other of the more southern countries, composed of stones measuring from 18 to 24 in. on top, and having a 6-in. depth, laid with comparatively close-fitting joints. On a level street these pavements furnish fairly good foothold for horses, and still have a smooth surface under wheel traffic.

Variations from the cubical shape of the "Belgian" block were introduced in German and English cities approximating more nearly to the dimensions of our granite paving block of today, but having the same general quality and wide joints as the old "Belgian" block.

A great part of the stone-paved streets in the continental cities (constituting generally a majority of the total area of carriageways) is paved with one or another of the above types of block, either a granite or a material like trap, the latter called whin stone in Great Britain, and porphyry in France and Germany. The granite, being a softer material and subject to more rapid wear, has not been as largely employed in the past, except on grades where its lack of extreme hardness makes it less slippery for horses' feet.

With the introduction of concrete foundations under stone pavements, came a reduction in the depth of blocks, and today where this foundation is used in France and Germany, the blocks have a depth of from 5 to 6 in., instead of 8 in. or more, as when laid without foundation.

In the German cities, two standard types of specifications are recognized for these two classes of pavement, and where concrete foundation is employed stones of smaller surface area and more closely dressed are used.

As characteristic of the extent to which concrete foundation is employed under stone pavements on the continent, however, reference may be made to the city of Paris, where only one-eleventh of the entire area of stone-block streets is so constructed. Liverpool has tried a great number of different types of block, both with and without concrete foundation, although for the past 25 years concrete foundations have been almost always used.

The fact that certain peculiarly shaped blocks are giving satisfaction in the streets of Liverpool does not indicate that this type of block is a standard nor one to be recommended for employment at the present time, because much difficulty is now experienced in obtaining any but the standard set from the Welsh and Scotch quarries which supply the English cities.

The best foreign practice is to lay stone pavement on a concrete foundation, as in this country, employing a cushion of sand or fine stone screening of 1 in. to 2 in. thickness, sometimes mixing in a small proportion of cement, in order to have subsequent rigidity in the cushion.

Joints are sometimes filled with gravel or fine crushed stone and then poured with tar or with a mixture of tar and sand; or, as is the practice in some cities, with a liquid cement grout. A combination of the two methods, using a mortar filled joint for half the depth with tar at the top, is sometimes used. For the large areas of stone pavements with no foundation, a great proportion has no filler in the joints other than fine gravel or sand.

On account of the lower rate of wages paid in Europe, it is possible to produce blocks more accurately dressed for the same amount of money than can be done in this country. Usually, a small amount of tool work can be done on the sides in order to permit the block to be laid with closer joints, but only in isolated instances where specially dressed blocks are employed are the joints less than ½ in. in width.

There were nowhere found any road authorities who recommended small cube-block pavement (that is, blocks 2 in., 3 in., and 4 in. on the side) as a competitor or sub-

FIG. 9. LAYING REPLANED OLD HARD-WOOD BLOCKS ON NEW CONCRETE FOUNDATION, BIRMINGHAM

FIG. 10. LAYING ROCK ASPHALT PAVEMENT; SPREADING HOT ASPHALT POWDER; HAND RAMMING; BERLIN

FIG. 11. VICTORIA EMBANKMENT, LONDON; AMERICAN ASPHALT ON MACADAM FOUNDATION; GRANITE BLOCKS ON TRAMWAY

stitute for the large granite-block type of pavement on a concrete foundation. Where laid in England, the small cubes are used as an alternative to some type of bituminous concrete.

The small-cube pavement streets and roads in Germany are almost always a means of substituting a harder surface for ordinary water-bound macadam. The blocks are frequently laid with sanded joints as a carpet coat on the old macadam; and when laid on a concrete foundation with tar-filled joints, they are still employed only on streets of light traffic where bituminous concrete or a sheet-asphalt surface would otherwise be used.

The engineers in Birmingham and the Borough of Chelsea have found the small-cube pavement satisfactory; the engineer of Battersea does not think it adaptable for employment on a city street. The experimental lengths laid on the Sidcup Road running out of London, where the small cubes have been used in competition with various other types, are too new to allow the drawing of definite conclusions, but appear to have been satisfactory up to the present time. The Liverpool engineers do not consider the small-cube pavement suitable on any class of city street; and they regard the rectangular granite

FIG. 12. BRICK PAVEMENT NEAR DOCKS, AMSTERDAM

block as best for heavy traffic and the bituminous macadam the best for the light-traffic residence streets.

The advantages of the small-cube pavement for suburban roads are: Low cost of maintenance and absence from dust when constructed with tar-filled joints. The disadvantages appear to lie in its noisiness, the tendency of the blocks to wear round due to wide joints, and their liability to become displaced and crushed on account of their small size. Cases were observed where this type of road surface showed material wear both under high-speed pleasure automobile traffic and slow-moving steel-tired motor and horse-drawn heavy traffic.

There are a few instances abroad of small areas laid with specially dressed granite block at a cost much in excess of anything we have, and presenting a surface almost as smooth as asphalt. But even could such a pavement be laid economically in this country, it is doubtful whether it would be advisable, on account of its having a surface too smooth and slippery.

WOOD PAVEMENTS

There are two classes, soft pine and hardwood. The blocks have dimensions approximating those used in this country—a depth of from 3 to 5 in., a width of 3 to 4 in., and a length averaging between 6 and 10 in.

Australian hardwood has been very extensively laid, both in England and on the Continent. Wherever it has to carry heavy traffic it has proved unsatisfactory. The blocks have a tendency to wear round and become rough and uneven. Some attempts have been made to take up the blocks from streets where this has occurred, plane off about ½ in. from the heads and relay them. This has been done with some success in various cities, but it is at best a temporary expedient, and in no city of first importance is it regarded as desirable to lay hardwood blocks at the present time. The blocks are always laid directly on a smooth concrete surface, being previously hand-dipped in tar and the surface poured with the same material. Soft wood blocks, made of Norwegian, Swedish and French pine and similar material, somewhat softer than our long-leaf yellow pine but very much resembling it in appearance, are being used with great success at the present time.

In the construction of soft wood-block pavement, the concrete foundation is finished with a perfectly smooth surface to the proper crown of the street and the blocks, previously treated with from 4 to 12 lb. of creosote oil per cu.ft., are laid directly on this surface.

After the blocks are laid in place, and this is usually done with the joints a trifle less close than in the American practice, the surface is swept with tar, which has been hand poured, as a joint filler. When this has sufficiently hardened, the entire surface is gone over with a thin coating of liquid cement grout, presumably to reduce the amount of stickiness from the tar, and the street is finally spread with a layer of granite screenings or crushed gravel, which traffic soon rolls into the soft surface of the wood. This produces a gritty nonslippery surface, which permits this type of material to be laid on grades up to 5% with entire success, under horse-drawn traffic. When well done, a wood pavement presents undoubtedly the finest street surface in existence; when the contrary is the case, they are about as poor as any to be found.

ASPHALT

The asphalt pavements of European cities are largely constructed from the natural asphalt rock found in various parts of Italy and southern France. It consists of a limestone impregnated with bitumen, which is mined in rough fragments, and run through a crusher and mill, and after being reduced to a fine powder, is heated to a high temperature, producing a material similar in consistency to the artificial asphalt topping used in this country; but it is of a brown color. The heated material is taken to the streets in wagons, spread to a depth sufficient to give a final thickness of from 1½ to 2 in. on the concrete foundation, and, after a preliminary rolling with a hand roller, is given its final compression by hand-ramming. Where the rock contains a deficiency in the amount of bitumen necessary, the required addition is made.

The City of Paris prohibits the reuse of any of the old wearing surface removed from the street, but on new pavements in Berlin and Charlottenburg the contractor is permitted to employ this old material in the proportion of about one-third of the total quantity. The practice is to take the old wearing surface as it is brought in carts

to the plants, mixing it in alternate layers with the broken rock from the mines, the mixture then being run through the crusher.

Rock-asphalt pavement has been employed for a long time in the principal European cities, producing a surface very similar to asphalt pavements of American cities, but somewhat harder and possibly a trifle more slippery under cold-weather conditions. In extreme warm weather it is liable to the same tendency encountered in this country to soften and roli. It is successfully employed in London, Paris, and Berlin, on streets that would not be regarded as suitable for our type of asphalt. It is nowhere regarded as satisfactory on any grade.

Abroad, asphalt pavement is usually thought to be too high priced to employ in quiet light-traffic residence streets to the extent followed in New York City. All new districts in Berlin, however, are being developed by asphalt roadways, and Paris has made contracts for the repaving with asphalt of a large extent of the existing wood, stone block and macadam. Vienna is now undertaking an extensive repaving of its old stone-block streets mainly with asphalt.

There have been some attempts to introduce American asphalts in competition with the European. The Thames Embankment has a Trinidad asphalt surface on the old macadam foundation, which has given satisfaction. A few experimental lengths of American asphalt have been laid in Berlin, and a company now operating there is preparing to make contracts for the use of some of the asphalts from this country. In general, however, the foreign engineers are satisfied with their own type of material and are somewhat averse to trying experiments with another.

The point must be emphasized that many of the superior features in regard to foreign asphalt streets, as they strike the observer's eye, are directly attributable to the much better and more thorough street-cleaning system in operation; while the points of criticism based on the condition of certain American asphalt streets can also be attributed in many cases to the faulty foundation conditions, which have not prevailed abroad.

Summary

These three types of surface—rectangular stone block, wood block, and compressed rock asphalt—are the prevalent surfaces for modern city street construction in the great cities of Europe. A great variety of other types can be found in small amounts and generally used where traffic is light. These include various kinds of compressed asphalt block, usually a thin slab or plate laid on concrete foundation; concrete blocks cast in forms under pressure, usually large slabs and laid more often for sidewalks than for other purposes; slag blocks, which present a smooth surface when new but rapidly deteriorate even under light traffic conditions; and brick, both ordinary hard burned and vitrified. Hard-burned bricks dipped in tar have been used in Brussels on some of the parkways, and there are many miles of brick roads in Holland.

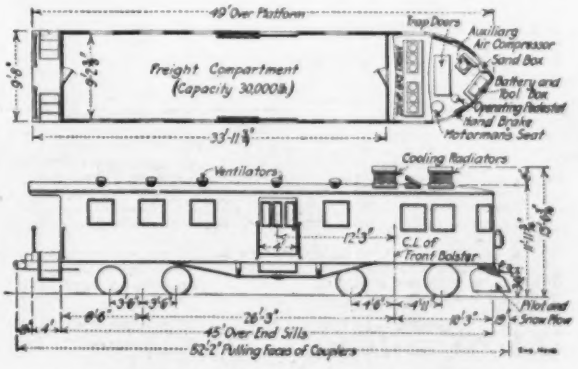
All classes of tar and bituminous macadam made under many processes, some of them patented and with various names, are being tried out and extensively used for suburban and country-road traffic, as in the United States. Tar macadam particularly is being largely introduced in the residence districts of European cities, under conditions similar to those where sheet asphalt on concrete is so often employed in the Borough of Manhattan, New York City.

After classifying all improved and modern pavements, it is found they are much in the minority as compared with those which may be termed ordinary or usual—large stone blocks on sand, or water-bound macadam.

A Self-Propelled Convertible Freight Car*

The Minneapolis & Northern Gasoline Motor Ry. has recently purchased a motor freight car to be used for freight and express service between Minneapolis and Anoka. It is a semiconvertible car which, during periods of heavy passenger traffic, can be used for transportation of passengers—removable seats and chairs being installed for that purpose.

The accompanying floor diagram and side elevation illustrate the general design of the car, from which it will be noted that the front end is wedge shaped and the rear end has a platform for passengers' ingress and egress. The now familiar depressed side-center entrance has not been used. The car structure consists of a metal underframe,



A Self-Propelled Convertible Freight Car

and continuous 2-in. grooved steel combination side posts and car lines extending from side sill to side sill with metal diagonal bracing. The outside and inside wall sheathing is of $\frac{13}{16}$-in. fir. The floor is of $1\frac{5}{8}$-in. fir. The motor truck is forward. The air-brake system is arranged for "straight" operation on the motor car and "automatic" on trailers.

The main dimensions are:

Length over end sills	45 ft.	
Length over platform	49 ft.	
Length overall	52 ft.	8 in.
Width over side sills	9 ft.	8 in.
Width over sheathing	9 ft.	9⅝ in.
Width overall	10 ft.	4½ in.
Width inside	9 ft.	2⅝ in.
Length freight compartment	33 ft.	11¾ in.
Height, rail to roof	11 ft.	11 $\frac{7}{16}$ in.
Weight	56,000 lb.	

An Appropriation of $100,000 for a Valuation of the property of the New York Telephone Co. by the Public Service Commission of the Second District (New York City) has been approved by Governor Glynn. The valuation will afford a basis for rate readjustment.

*From information furnished by the McKeen Motor Car Co., Omaha, Neb., builder of the car described.

Construction Difficulties with Stockton St. Tunnel, San Francisco

The chief engineering features of the Stockton St. tunnel in San Francisco were described in ENGINEERING NEWS, Feb. 12, 1914, p. 344. The contractors who are performing the work have encountered a serious problem in supporting the enormous weight of the shattered shales and schist traversed by the bore. Owing to the looseness of this material and to the necessary flatness of the arch, at certain locations a great proportion of the dead

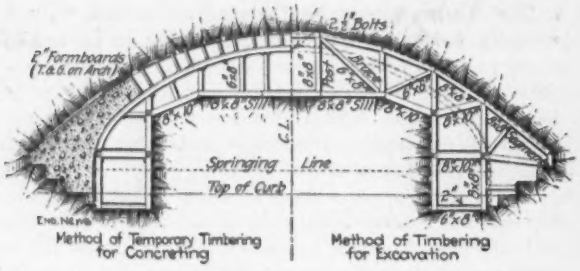


FIG. 1. ORIGINAL METHOD OF TIMBERING STOCKTON ST. TUNNEL, SAN FRANCISCO

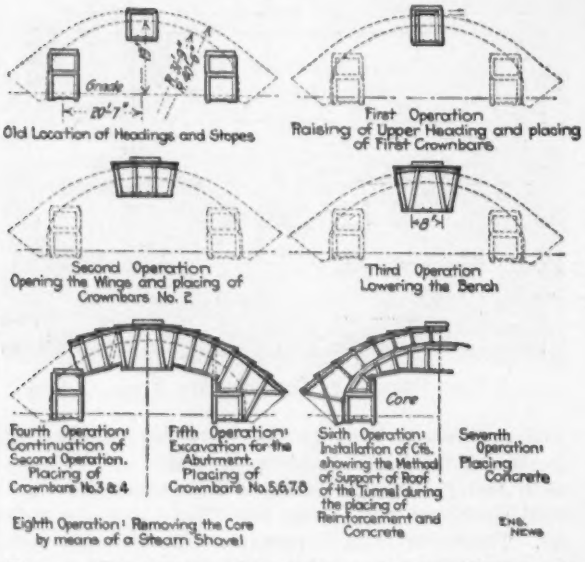

Old Location of Headings and Stopes
First Operation Raising of Upper Heading and placing of First Crownbars
Second Operation Opening the Wings and placing of Crownbars No. 2
Third Operation Lowering the Bench
Fourth Operation: Continuation of Second Operation. Placing of Crownbars No.3 & 4
Fifth Operation: Excavation for the Abutment. Placing of Crownbars No.5,6,7,8
Sixth Operation: Installation of Cts. showing the Method of Support of Roof of the Tunnel during the placing of Reinforcement and Concrete
Seventh Operation: Placing Concrete
Eighth Operation: Removing the Core by means of a Steam Shovel
Core

FIG. 2. DETAILS OF PROGRESS OF LATER METHOD OF TIMBERING DEVISED BY L. F. GERDETZ

weight of the material between the extrados and the ground surface must be supported by the falsework until the concrete lining is in place. The original plan of timbering is shown in Fig. 1. Near the portals this method was satisfactory, but when the initial drifts had been advanced a distance of 120 ft. from the south portal a slide of loose schisty material, which extended to the surface, temporarily blocked progress in the east drift.

After clearing the débris, instead of continuing to use the 8-in. transverse steel I-beam, the type of timbering illustrated in Fig. 2, proposed by L. F. Gerdetz, consulting engineer for the contractors, was adopted. This drawing shows each successive operation as followed in advancing the tunnel. So great was the stress to which the timbers were subjected that in one instance while performing the third operation the heavy longitudinal crown bars were crushed almost to failure. The hasty substitution of additional and larger timbers saved the section from failure.

A small portion of the tunnel is through sandstone, and in this formation the original concrete section was placed for the lining, wherever the formation was sufficiently solid to warrant its use. At other locations a modified and heavier section was substituted.

FIG. 3. VIEW OF LATER TIMBERING

The present city engineer revised the plans and designed the thicker section. This resulted in an additional expenditure of $60,000 for 800 lin.ft. of tunnel lining. The new concrete lining is carrying the pressure successfully without any signs of settlement and makes this work monumental as the widest long span tunnel yet constructed.

New York City Ordinances for the Prevention of Sewer Explosions

The disastrous explosion at the Chelsea St. pumping station of the Metropolitan sewerage system in East Boston, Mass., June 1, again brings to the front the dangers resulting from gasoline and oils in sewers. With the universal use of gasoline motor vehicles, these explosions are increasing in frequency in every large city and must be stringently guarded against. Not only must laws be passed to prohibit the escape of gasoline and inflammable oils into sewers, but frequent investigations should be made of the sewer air in suspicious districts to make sure the law is being complied with.

New York City has had its share of explosions, but of late they have not been so frequent or so serious as they were a few years ago. The New York ordinances covering this point are given below:

EXTRACT FROM CODE OF ORDINANCES OF THE CITY OF NEW YORK

Section 561. No connection with or opening into any sewer or drain in the City of New York, either public or private, shall be used for the conveyance or discharge, directly or indirectly, into said sewer or drain, of any volatile inflammable liquid, gas or vapor, it being noted that a volatile inflammable liquid is any liquid that will emit an inflammable vapor at a temperature below 160° F.

Section 562. Every occupant of any premises which may be connected with a sewer or drain, public or private, who shall use or permit or allow to be used said sewer or drain for such purposes as hereinbefore specified in Section 1, and every owner of any premises who shall use, permit or allow the use of such sewer or drain for such purposes shall be deemed to have violated the provisions of this ordinance and be guilty of misdemeanor, and shall be punished upon conviction thereof by a fine of $50, or imprisonment for 30 days. (Ord. app. July 6, 1906).

EXTRACT FROM THE REGULATIONS OF THE MUNICIPAL EXPLOSIVES COMMISSION

Section 376. No garage permit authorizing the storage of volatile inflammable oil shall be issued for any premises which are not provided with an oil separator, trap or other similar apparatus attached to the house drain for the purpose of preventing volatile inflammable oils from flowing into the sewer; provided, however, that the Fire Commissioner may, upon the recommendation of the Municipal Explosives Commission, exempt from the requirements of this section a garage draining into a short sewer line.

Section 396. Each oil separator installed in a garage shall be connected to the house drain, and shall be so arranged as to separate all oils from the drainage of the garage.

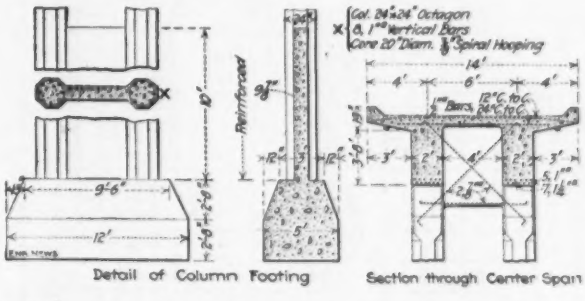
A Continuous Reinforced-Concrete Girder Bridge for Interurban Cars

A reinforced-concrete girder bridge of simple details but effective design has recently been completed across White Rock Creek, about 6 miles outside of Dallas, Texas, for the Eastern Texas Traction Co., an interurban electric line to run between Dallas and Greenville. Fig. 1 shows the general details and Fig. 2 a view when it was nearly completed.

White Rock Creek has an intermittent flow; it is generally nearly dry, but at flood times reaches over a wide area of bottom lands. In addition, the railway crossing

FIG. 2. VIEW OF BRIDGE DURING MODERATELY HIGH WATER

The west abutment (right hand in Fig. 1) is founded on a satisfactory clay and the other abutment and piers on rock. Work was carried out by the company's forces, who, from inexperience in this type of work, had some



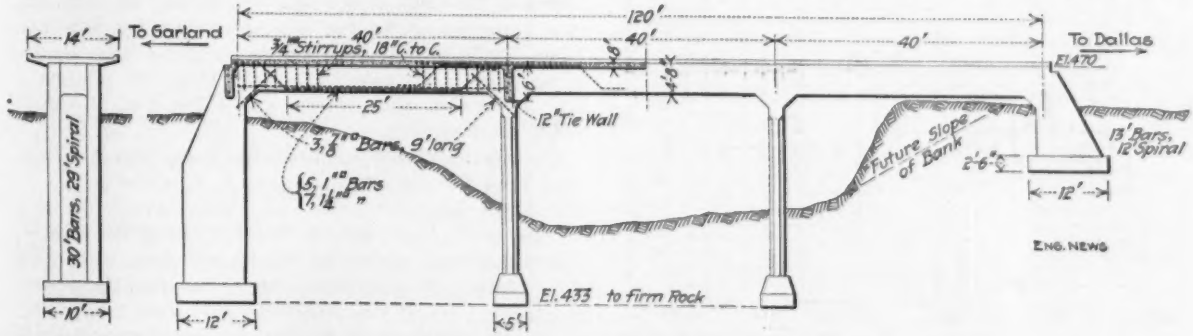


FIG. 1. DETAILS OF WHITE ROCK CREEK BRIDGE, EASTERN TEXAS TRACTION CO.

is within the back-water area of the White Rock Reservoir of the Dallas water-supply, so that ample provision had to be made for the water section. This consideration, together with the reduced cost due to simplicity of construction, led to the adoption of the girder bridge shown.

In brief, this bridge consists of three 50-ft. spans resting on two intermediate column bents and two twin-wall abutments. The roadway, for a single-track line, is a ballasted track laid on a solid concrete floor, continuous between abutments and forming a double T-beam with the girders, which in turn are monolithic with the bents and the abutments. There is no expansion joint in the structure, it being considered that it was strong enough to take all movement from end to end. The approaches are wooden trestles, with the end stringers resting on the abutments. The reinforcement of the superstructure is the normal rod system; the columns of the bents are reinforced by spirals.

trouble, but it is thought that for future similar bridges on the same line, better progress will be made. The bridge was designed by W. E. Beilharz, office engineer, under the direction of W. A. Obenchain, Chief Engineer of the company.

Road Improvement Work in Ohio during the present season will amount to about $15,000,000, according to a recent estimate of State Highway Commissioner James M. Marker. Of this sum $9,000,000 will be spent on contracts under the supervision of the State Highway Department and the remaining $6,000,000 directly by the counties and townships. About 320 miles of road are now being improved, 140 miles with macadam, and about 90 miles each with brick and concrete pavements. Since the organization of the State Highway Department in 1905 contracts have been let for the improvement of 67 miles of road. The only states which, it is claimed, surpass Ohio in the percentage of improved roads over all roads are Massachusetts, 49%, and Rhode Island, 49.1%, while Ohio has 34% of its highways improved.

Reducing the Per Capita Consumption of Water, Metropolitan District, Boston, Mass.*

The accompanying chart shows the remarkable results obtained by a systematic campaign to reduce the waste of city water in the Boston Metropolitan Water District. Of the 18 towns and cities using the water of the Metro-

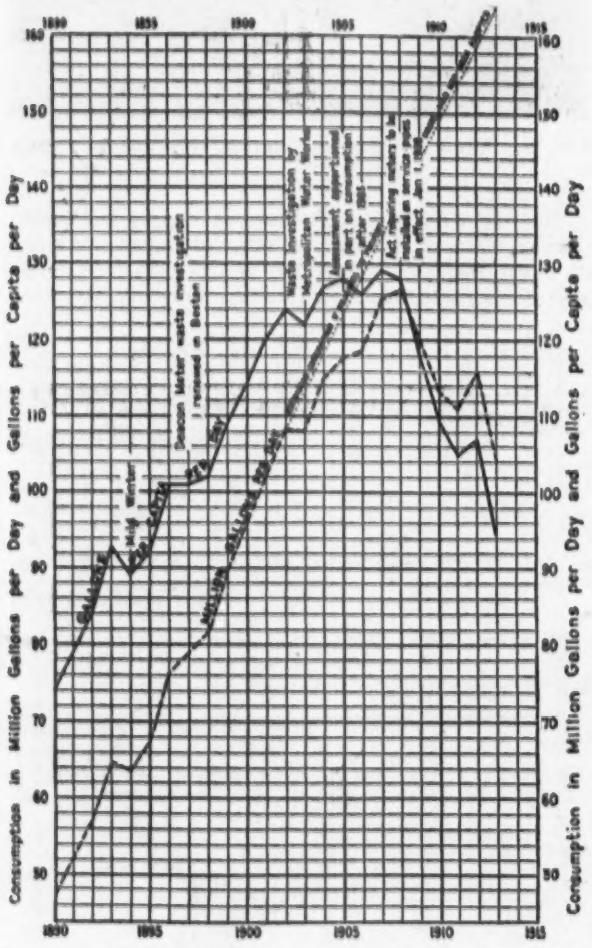

Consumption in Million Gallons per Day and Gallons per Capita per Day
Consumption in Million Gallons per Day and Gallons per Capita per Day
1890
1895
1900
1905
1910
1915
Boston Water waste investigation
Metropolitan Water Board
Act requiring meters to be installed on services in effect Jan. 1, 1908

Diagram Showing Reduction of Water Consumption in the Metropolitan Water District

politan Water District, ten have practically all their services metered. Of the total of 168,300 services in use Dec. 31, 1913, over 57% were metered. Had the per capita consumption continued at the rate at which it stood ten years ago, some 60,000,000 gal. per day more water would now be required and the Metropolitan Water Board would have spent and would be spending millions of dollars to develop new supplies.

Besides the service connection meters every effort is made to detect and repair leaks in mains. To simplify this task there are now 71 Venturi meters connected with the works. Four of these are at the Wachusett Dam and are used in measuring water drawn from the Wachusett Reservoir. Two are located on the pipes leading from the Sudbury Dam and are used for measuring water drawn from the Sudbury Reservoir and delivered into the Weston Aqueduct. Sixty-five are on connections through which water is supplied to the different municipalities. There are also 3 Hersey disc meters, 1 Hersey torrent meter and 5 Hersey detector meters used in measuring small quantities which cannot be conveniently measured with meters of the Venturi type. The work of caring for these meters in the Metropolitan District has been done by two men, assisted at times by a third. The cost of the work connected with the reading, operating and maintaining of these meters has been $1,974.38.

*Data from the recent report of the Metropolitan Water and Sewerage Board, Boston, Mass.

Methods Used in Investigation of Explosive Gases and Oils in Sewers

By G. J. White*

City engineers are interested in the investigation of sewer explosions, yet perhaps but few of them have much knowledge of the methods used to determine whether the gas in a sewer is explosive or not, and if so, what makes it explosive. The purpose of this article is to give the average engineer, who is not a chemist, an outline of a method which may be used to determine if a sewer gas is explosive. A complete gas analysis is a long tedious process and if the gas is not explosive either alone or when mixed with air, the engineer has but little interest in it.

Gas Sampling

Gas-sampling pipettes (Fig. 1) of the mailing type (fitted in tin tubes or wooden boxes), may be purchased at a reasonable price and are convenient for handling. These should hold at least 300 c.c. to give a large sample to work on. An aspirator bottle (Fig. 2) holding a little more than the pipettes and a few feet of rubber tubing are necessary.

The pipettes should be filled with sewage which is saturated with the gas with which it is in contact. To do this fill the aspirator bottle with sewage, attach the rubber tube to the bottle and the lower nipple of the pipette; elevate the bottle above the pipette and open both cocks of the pipette, allowing the sewage to flow into the pipette by gravity. When the pipette is full, close both cocks, remove the rubber tube leading to the aspirator bottle and return the pipette to its case. As many pipettes as are necessary to secure the required number of samples may be thus prepared on the surface before entering the sewer.

The pipette is now taken into the sewer, to the point from which it is desired to secure a sample of the gas present, removed from its case and held in a vertical position with both cocks open. The sewage flowing out draws the gas in and when the sewage is all out, the pipette is full of gas. The stop cocks are now closed and the pipette returned to its case and the case marked for identification.

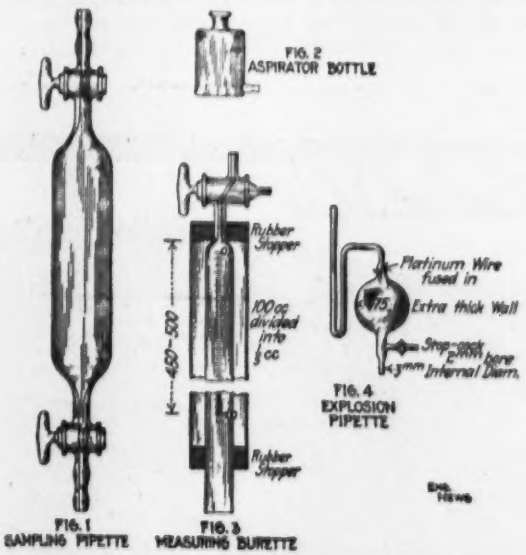
Examination in the Laboratory

For the examination in the laboratory, a water-jacketed gas-measuring burette (Fig. 3) with a three-way cock

*Gas Inspector, Department of Public Work, Detroit, Mich.

similar to a Hempel burette is necessary for the gas measurements. An explosion pipette (Fig. 4) connected up with two or three batteries and a good sparking coil is necessary for the explosion tests. The explosion pipette should be mounted in a wooden case with a sliding front of heavy plate glass in order that the operator may watch the explosion, yet be amply protected from harm in case of a too violent explosion.

The sampling pipette is removed from its case and mounted in a suitable holder in position to attach the capillary tube from the gas-measuring burette. The aspirator bottle is filled with sewage and placed on a shelf above the pipette, the end of the rubber tube being closed with a pinch cock. The rubber tube is now allowed to fill with water and slipped over the lower nipple of the pipette. The capillary connecting tube is attached to the burette with heavy rubber tubing and securely wired. The aspirator bottle connected with the gas-measuring burette is filled with sewage and the bottle raised, with the three-way cock open straight through, until water appears at the end of the capillary tube. The upper nipple of the pipette is now filled with sewage



COLLECTING AND SAMPLING APPARATUS FOR TESTING EXPLOSIVE CHARACTER OF SEWER GASES

and connected to the capillary tube. Both stop cocks on the sampling pipette are now opened and the three-way cock on the burette is opened to connect with the pipette. By lowering the aspirator bottle, in connection with the burette, the desired amount of the sewer gas can be drawn into the burette, being replaced with sewage from the aspirator bottle connected with the pipette. About 25 c.c. of gas should be drawn over and allowed to stand three minutes (to allow water on the sides of the burette to run down), before measurement. In the meanwhile the cocks on the pipette are closed, the pipette removed from its holder, returned to the case and the explosion pipette connected to the capillary tube. The three-way cock is now turned to connect through from the explosion pipette to the air, the stop cock on the explosion pipette opened, the aspirator bottle filled with mercury raised to allow the explosion pipette to fill with mercury. A cushion (about ½ in.) of water should be carried on top of the mercury in the explosion pipette. When the explosion pipette is full and water appears at the three-way cock, the cock is turned to connect through from the burette to the explosion pipette, the mercury bottle lowered and the sample of gas drawn into the explosion pipette. When the gas is all over, the three-way cock is closed and a pinch clip is placed on the rubber tubing connecting the capillary tube to the explosion pipette—to protect the gas-measuring burette in case of a too violent explosion. The mercury bottle is now raised to the level of the mercury in the explosion pipette and the stop cock closed. The gas sample is now confined in the explosion pipette over mercury and at atmospheric pressure. The switch connected with the batteries is then closed for a moment, passing an electric spark through the gas. If the gas is explosive, the operator will see a flash of flame through the gas. If the gas is not explosive in its original condition, it may only need oxygen to make it explosive; so it is passed back to the gas-measuring burette, the capillary tube disconnected and equal parts of air drawn into the burette. After measurement the mixture is passed into the explosion pipette and a spark sent through it. Various mixtures of the gas and air, under various conditions of pressure may be passed into the explosion pipette and sparked. If it is found that the sewer gas cannot be exploded alone or when mixed with air, then measured amounts of city gas from a gas tap may be added to find the amount needed to make the sewer gas explosive.

If it is desired to measure the relative intensity of the explosion of various gas mixtures, a sensitive recording gas-pressure gage may be connected in series with the explosion pipette and the mercury bottle and the blow of the explosion thrown directly onto the recording chart. While this method will not give absolute measurements of the intensity of the explosions, it will give relative measurements which are of value.

If it is found that the sewer gas is not explosive alone or when mixed with air, the engineer is no longer interested in it. If it is found to be explosive, then the remainder of the sample in the sampling pipette should be sent to an experienced gas analyst for analysis to determine what makes it explosive.

EXAMINATION OF SEWAGE FOR OIL

At least ten liter samples of the sewage should be obtained in bottles with a small neck. Two or three pounds of common salt (NaCl) are added to the sewage to make a fully saturated brine and the bottles are allowed to stand at least 24 hr. The salt increases the density of the solution and hastens and makes more complete the separation of the oil. After standing a sufficient length of time, the oil is siphoned off the top (preferably with a vacuum pump) into a distilling flask with a side-arm outlet. It is impossible to prevent some of the water coming over with the oil, so the flask is now connected with a Leibig condenser and the oil distilled off at 205° F. This will give a fairly good separation of the oil from the sewage and does not necessitate the distilling of the entire sample. If it is desired the oil may be redistilled and fractionated to determine the boiling point of the various fractions. A Westphal balance or hydrometer may be used to determine the specific gravity of the fractions for further identification.

Two Interesting Bridges on the El Paso & Southwestern Ry.

The bridges on the El Paso & Southwestern line between Fairbanks and Tuscon, Ariz., include a riveted-truss bridge in which the trusses have no counters, and a plate-girder bridge with three-post towers which are triangular in plan. The other structures are mainly concrete arches and concrete slab-deck trestles. The bridges are designed for Cooper's E-55 loading. J. L. Campbell is engineer of the railway.

Bridge Trusses without Counters

Near Irene, Ariz., the line crosses the Southern Pacific Ry. and the cañon of Cienega Creek by a bridge having two riveted-truss deck spans of 168 ft., with a single 50-ft. plate-girder span (65 in. deep) at one end and two 75-ft. plate-girder spans (85 in. deep) at the other end. This bridge is shown in Figs. 1 and 2. The assumed dead-load for the truss spans is 2100 lb. for the trusses, 600 lb. for the floor and 500 lb. for the track, or 3200 lb. per lin.ft. of bridge; for the girder spans it is 1100 lb. and 800 lb. for steel and 500 lb. for track, making 1600 and 1300 lb. for the 75-ft. and 50-ft. spans, respectively.

The trusses are of the parallel-chord Pratt type, with vertical end posts. They are 23 ft. 9 in. deep, and have a panel length of 23 ft. 9 in., the length c. to c. of end pins being 166 ft. 3 in. The expansion bearings are on the middle pier and the fixed shoe bearings on the end piers. The trusses are spaced 15 ft. c. to c., and have plate-girder floorbeams riveted between the posts. The floorbeam at the outer end of each span is 60 in. deep; all the others are 46 in. deep. Upon the floorbeams are two lines of 38-in. plate-girder stringers 7 ft. 6 in. apart, which carry ties 10x10 in., 10 ft. long, boxed out ½ in. over the flanges and carrying guard timbers 6x8 in., which are boxed out 1 in. over the ties. Each third tie is secured to the stringers by ¾-in. hook-bolts which pass through the guard timbers.

The top chords of the trusses are of trough section, with two 22-in. web plates (16 in. apart), four outside flange angles 4x4 in., and a top cover-plate 26x⅝ in., while double lacing is riveted across the lower flanges. The bottom chords are similar, but with double lacing top and bottom, and in the three middle panels the 22-in. web-plates are reinforced by outside 13-in. plates. The vertical end posts are of similar section to the top chord, with the addition of an interior transverse diaphragm or web-plate secured to the side plates by four angles. The

Fig. 1. Bridge with Riveted Truss Spans of 166 Ft. 3 In., across Cienega Creek; El Paso & Southwestern Ry.

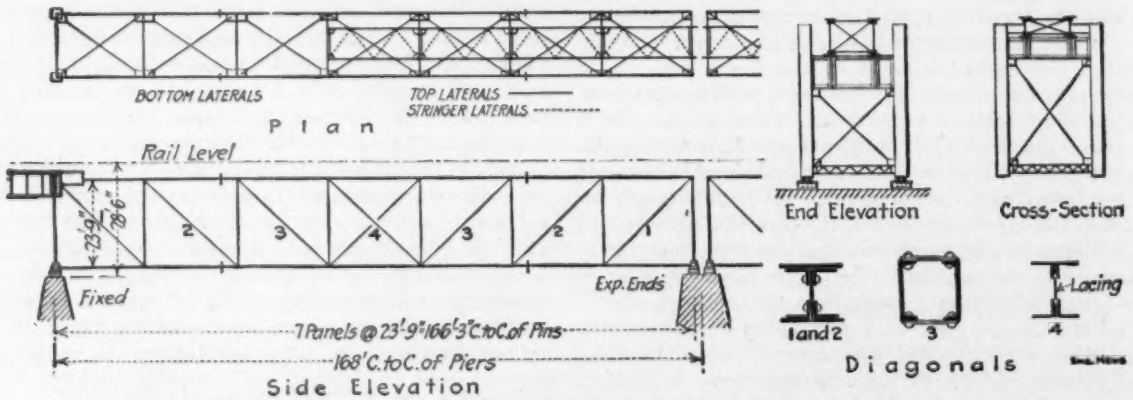


Fig. 2. Riveted Deck Truss Spans for Cienega Creek Bridge

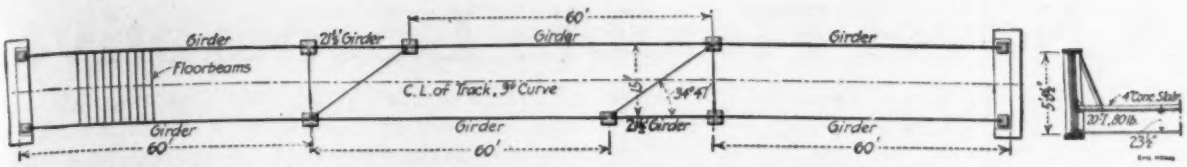


FIG. 3. THREE-SPAN PLATE-GIRDER BRIDGE WITH THREE-POST TOWERS; EL PASO & SOUTHWESTERN, RY.

shoe pins are 8 in. The intermediate posts are of box section, built up of plates and angles or of a pair of channels (with flanges inward).

The diagonals in the first two panels at each end are to the girders by angle connection plates. Over these beams is laid a 4-in. concrete deck, which is sloped up against the girder web on each side. This construction is shown in Fig. 3.

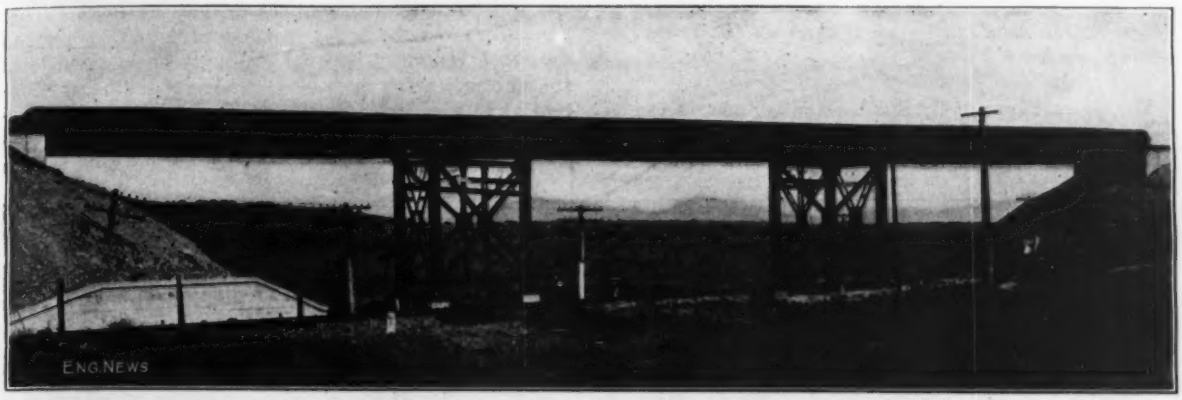


FIG. 4. PLATE-GIRDER BRIDGE WITH THREE-POST TOWERS

of H-section (three plates and four angles), while those of the next panels are composed of two 15-in. channels with flanges inward. In the middle panel, each diagonal is of four angles and transverse web lacing, with two connection plates 45 in. square at the intersection. All connection plates are large, to provide for ample riveting.

BRIDGE WITH THREE-POST TOWERS

At Mescal, Ariz., the line again crosses over the Southern Pacific Ry. It is carried by a through plate-girder bridge having three 60-ft. spans, and the angle of skew (34° 47') led to the use of the three-post pier arrangement shown in Fig. 3. Each tower has one 21½-ft. girder to fill in between the two 60-ft. girders, and is braced on all three sides. A view of this bridge is shown in Fig. 4.

Each column is composed of a pair of 15-in. channels (with flanges inward), a diaphragm or web-plate 15x⅜ in., and four angles 5x3½ in., connecting the web to the channels. The open sides have no bracing or batten plates. The shoe rests on a concrete pedestal and the top has a ½-in. cap plate 25x25 in., secured to the column by four angles 4x6 in. The struts, braces and hangers are pairs of angles with lacing or batten plates over the flanges. The hangers are used only on the two longer sides of the tower.

The 60-ft. girders have ½-in. web-plates 68½ in. deep, four flange angles 8x8 in., and cover-plates $20x\frac{9}{16}$ in. They were made in half lengths and spliced in the field. The 21½-ft. girders have the same web-plates, with flange angles 6x4 in., and no cover-plates. A solid floor is used, so that the ordinary ballasted track is carried across the bridge. The floor consists of 20-in. transverse I-beams resting on the inner flange angles and secured

Dust on Underground Railways in Paris has been investigated owing to the condition of the air in the tunnels of the Metropolitan line being much worse than in those of the North-South line. It is found that the former contains 134 milligrams of dust per c.c. as against only 6 to 16 milligrams in the latter. The principal cause (on the Metropolitan) appears to be in the rails, which are of relatively soft steel, and in the braking, the brakeshoes being of cast iron. On the North-South line, the rails are of harder steel and the brakeshoes are faced with a tar-treated fabric, which reduces wear and noise. Another cause is in the car-floor construction, the cars of the former line being of wood with narrow wearing strips which make it difficult to clean the floor. On the latter line the floor is covered with a composition which gives a smooth and uniform surface that is readily cleaned with wet sawdust. Another proposed plan, as noted in "The Engineer" (London) is to cover the ballast with tiles at the stations, so that the track can be cleaned and the dust removed.

A Reinforced-Concrete Pier Damaged—What appears to be a serious imperfection in the concrete jetty erected by the Gladstone Harbor Board, Queensland, has been noted by E. A. E. Cullen, Engineer for Harbors and Rivers, who has recommended that the necessary repairs be undertaken forthwith. Mr. Cullen, who inspected the jetty, submitted a report as follows: "It is a matter of great disappointment to find that a reinforced-concrete wharf may require a periodic maintenance, as it was hoped that such would not be the case, except for surface wear and tear. What has occurred at Gladstone is that the concrete in the beams has not proved impervious to the water everywhere, and in consequence moisture has in places reached the steel reinforcing bars, causing corrosion. The expansion of the rust caused cracks in the concrete. Another factor which may have produced cracks, permitting moisture to enter, is the severe punishment the jetty receives at times from the impact of steamers. To repair the structure it will be necessary to cut away the damaged concrete, clean any rust off the bars, and restore with fresh mortar. It is very difficult to estimate the cost of such work. Probably it will not exceed £250. The structure was completed in 1908, and showed no visible deterioration until recently, save for a few rust spots in places where the steel had been insufficiently covered with mortar. These were cut out and restored in November, 1912."—"The Commonwealth Engineer," Melbourne, Australia.

A Novel Flexible Locomotive

SYNOPSIS—Several types of locomotives with flexible wheelbase have been designed for railways having numerous and sharp curves, and where the limiting conditions of power and axle load necessitate distributing the load over several axles and a considerable total length of wheelbase. The general principle of these is to mount the engine on groups of wheels, some or all of which are carried in swiveling trucks, while the wheels of each group are driven directly or by gearing. The accompanying article describes an English design of flexible locomotive which is in use on a number of railways, and which has the peculiar feature of carrying the boiler suspended between the trucks.

The Garratt type of flexible locomotive, now in use on some foreign railways, has the boiler mounted on a girder frame whose ends are pivoted upon two steam trucks, there being no wheels under the boiler. This is the distinctive feature which differentiates it from all other flexible locomotives (articulated or otherwise), as noted in a brief description in our issue of Apr. 13, 1911. Fig. 1 shows a freight locomotive of this type for the Tasmanian Government Railways. It will be seen that the engine consists of three separate and distinct units: the boiler with its girder frame, and the two steam trucks or driving trucks. The pivots or king-pins forming the attachments of the boiler frame to the trucks are near the inner ends of the trucks (or nearly over the inner driving axles), and the requisite weight on the forward part of each truck is supplied by a water tank.

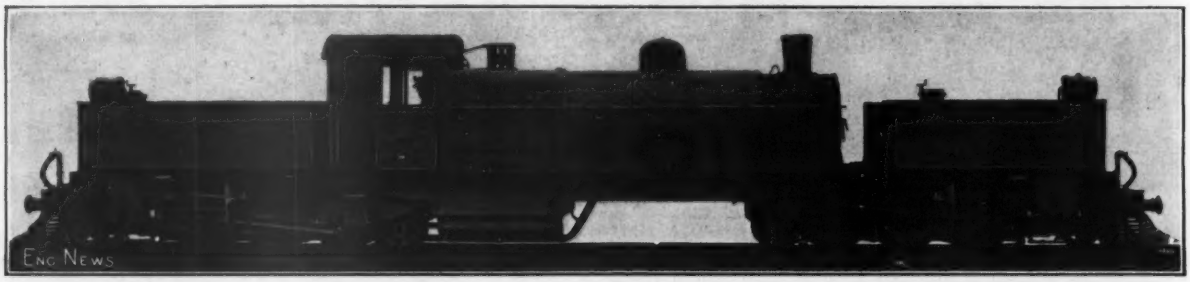


FIG. 1. FREIGHT LOCOMOTIVE OF THE GARRATT FLEXIBLE TYPE; TASMANIAN GOVERNMENT RAILWAYS

In the Fairlie and Mallet engines the wheels are divided into two groups, each with its own cylinders, but all the wheels are placed beneath the boiler. The Fairlie engine has two swiveling trucks, while the Mallet engine has the rear group carried in rigid frames and the leading group carried in a swiveling truck having an articulated connection at its rear end. In furnishing us with information as to the newer type of engine, the inventor calls attention to some points in comparing the Garratt type with the Fairlie and Mallet types, especially the relative permissible sizes of boilers and wheels under like conditions of gage, and the relative stability of the three types.

In the Garratt type, as the wheels are not under the boiler, both they and the boiler may be of any size that will pass through the clearance limits. In the Mallet and Fairlie types the wheels are under the boiler, and therefore limit one another. Mr. Garratt thinks it would be difficult to build a high-speed engine on those designs, because, if the wheels are to be of suitable diameter for fast running, there would not be room for a large boiler and firebox of sufficient capacity. However, Mallet engines with 73-in. wheels and weighing 188 tons are in use in passenger service on the Atchison, Topeka & Santa Fé Ry. They are of the 4:4:0—0:6:2 type, and operate on grades of 1.75% with curves of 16°.

It is claimed that in the Garratt arrangement the trucks swing more freely and follow the curves with less resistance than in engines having the trucks under the boiler. As the boiler frame does not extend beyond the truck centers, when the engine is on a curve there are no overhanging ends of the frame of the boiler (tangential to the curve) to reduce the stability. With regard to stability, Fig. 3 shows three types of flexible engines on the same curve, the Mallet engine being shown without its tender and the other two being tank or self-contained engines. The portions shaded black indicate weight displacement unfavorable to stability, and the cross-hatched portions indicate weight increasing the stability. It is noted that in the Garratt engine, the sharper the curve the greater the favorable displacement of weight, while in the Mallet and Fairlie types, the unfavorable condition increases as the curve becomes sharper.

Further, as the rear-wheel system of the Mallet type is rigid, the center line of the engine is tangential to the curve, as from the center of the rear-wheel system, thus throwing greater weight on the outer leading wheels, which at high speeds, may exceed the original fixed maximum weight. The engine described is the invention of

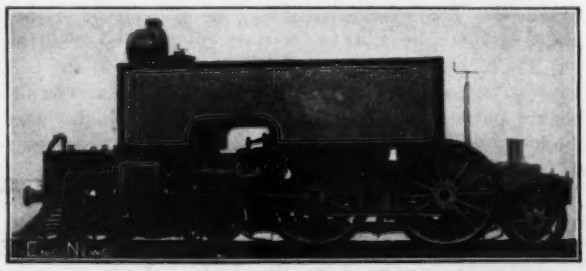


FIG. 2. STEAM TRUCK OF A PASSENGER LOCOMOTIVE OF THE GARRATT TYPE; TASMANIAN GOVERNMENT RAILWAYS
(Each truck has four cylinders.)

Herbert W. Garratt, 9 Ellerker Gardens, Richmond (Surrey), England, and is built by Beyer, Peacock & Co., locomotive builders, Gorton Foundry, Manchester, England. For information regarding it we are indebted to Mr. Garratt and the builders.

Garratt Locomotives for the Tasmanian Government Railways

A Garratt freight locomotive for the Tasmanian Government Railway is shown in Fig. 1, while Fig. 2 shows one of the steam trucks for a passenger engine for the same railways. In the former, each steam truck is of the 2:6:2 type, with six driving wheels, while in the latter each truck is of the 4:4:2 type, with four driving wheels. They are for service on the main lines (3-ft. 6-in. gage), where the maximum grades are 2.5% (up to 6½ miles long) with curves as sharp as 17°.

The passenger engine has four cylinders to each truck, 60-in. driving wheels with 6-ft. rigid wheelbase, and a maximum axle load of 12 tons. It is designed for a maximum speed of 55 mi.p.h., and to haul a train load of 200 tons at 30 mi.p.h. on the maximum grade with 17° reverse curves. The freight engine has two cylinders to each truck, 42-in. driving wheels with 8-ft. rigid wheelbase, and a maximum axle load of 9½ tons. Its tractive force, at 75% boiler pressure, is 28,284 lb. The boilers are alike and the parts of the two engines are made interchangeable as far as possible. The ordinary engines used in the same service are 4·4:0 passenger engines(which haul 100-ton trains), and 2:6:0 and 4:6:0 freight engines, all having tenders.

The absence of side tanks and of wheels beneath the boiler permitted the use of a barrel of large diameter and moderate length, with a wide and deep firebox of the Bel-

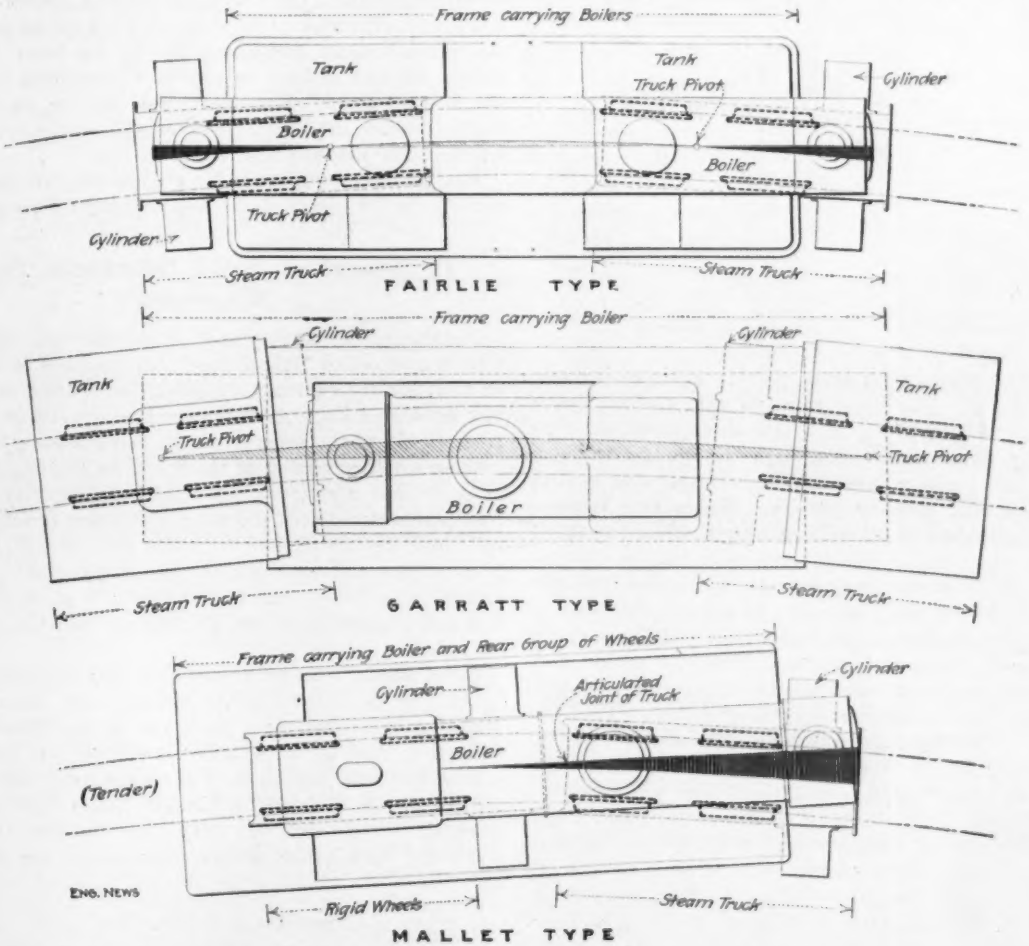


Fig. 3. Diagram Indicating Relative Stability of Flexible Locomotives on Curves

(Black areas indicate weight unfavorable to stability on curve. Shaded areas indicate weight favorable to stability on curve.)

paire type. The grates are designed for burning the inferior native coal, but provision has been made for using oil fuel, in view of the development of oil wells in Tasmania. The boiler is of steel, with copper firebox, steel tubes and a 24-tube Schmidt superheater. The steam pipes have ball joints directly over the king-pin pivots. The exhaust from the two groups of cylinders is led to a double exhaust nozzle in the smokebox, having a central opening for the forward cylinders and an annular opening for the rear cylinders.

In the passenger engine, the driving and rear axles of each steam truck are equalized. The four cylinders drive the first driving axle (which is of nickel-chrome steel), the inside and outside cranks being placed at

DIMENSIONS OF GARRATT FLEXIBLE LOCOMOTIVES

	—Tasmanian Govt. Rys.— Passenger	Freight	W. Australian Govt. Rys.	Belgian Congo Ry.
Gage	42 in.	42 in.	42 in.	30 in.
Wheel plan (each truck)	4: 4: 2	2: 6: 2	2: 6: 0	0: 6: 0
Driving wheels	(8) 60 in.	(12) 42 in.	(12) 39 in.	(12) 33½ in.
Outer truck wheels	(8) 28½ in.	(4) 27 in.	(4) 30 in.	none
Inner truck wheels	(4) 34½ in.	(4) 27 in.	none	none
Wheelbase, driving	6 ft. 0 in.	8 ft. 0 in.	7 ft. 6 in.	7 ft. 4 in.
Wheelbase, each group	20 ft. 9 in.	17 ft. 8 in.	13 ft. 9 in.	7 ft. 4 in.
Wheelbase, total engine	61 ft. 10 in.	56 ft. 8 in.	47 ft. 0 in.	35 ft. 0 in.
Distance between pivots	30 ft. 6 in.	29 ft. 8 in.	25 ft. 0 in.	.....
Weight: (each group); drivers	24 tons	28 tons	25½ tons	.....
Weight, outer truck	15 tons	8 tons	7 tons	.....
Weight, inner truck	8 tons	9 tons	.....	.....
Weight, total, each group	47 tons	45 tons	32½ tons	.....
Weight, total engine	94 tons	90 tons	65 tons	50 tons
Weight, total, empty	72 tons	67 tons	55½ tons	.....
Cylinders	(8) 12x20 in.	(4) 15x22 in.	(4) 12½x20 in.	(4) 12½x14 in.
Tract. power per lb. m.e.p. in cyls.	192 lb.	235 lb.	160 lb.	.....
		Both engines		
Boiler, diameter		5 ft. 3 in.	5 ft.	.....
Superheater		Schmidt	Schmidt	.....
Working steam pressure		160 lb.	175 lb.	200 lb.
Firebox		78x62 in.	57x56 in.	.....
Firebox, depth		6 ft. 3 in.	5 ft. 5 in.	.....
Tubes, ordinary		No., 225; dia., 1¾ in.	No., 288; dia., 1¾ in.	No., 119; dia., 2¼ in.
Tubes, superheater		No., 24; dia., 5½ in.	.....	.....
Tubes, length		11 ft. 3 in.	9 ft. 4 in.	10 ft. 8 in.
Superheater steam pipes		dia., 1½ in.	.....	.....
Heating surface, tubes		1530 sq.ft.	1233 sq.ft.	1097 sq.ft.
Heating surface, firebox		156 sq.ft.	107 sq.ft.	123 sq.ft.
Heating surface, total		1686 sq.ft.	1340 sq.ft.	1220 sq.ft.
Superheating surface		333 sq.ft.	.....	.....
Grate area		34 sq.ft.	22½ sq.ft.	.....
Total capacity of tanks (2)		3000 gal.	2000 gal.*	.....
Capacity of coal bunker		4 tons	2 tons	.....

* 1220 gal. on front truck.

180°. The Walschaerts valve gear is used, with screw reversing gear. The inner carrying axle of each group has a lateral play of ¾ in. The water tanks are connected by equilibrium pipes, with flexible connections, and the coal bunkers have inclined bottoms so as to feed the coal to the deck by gravity. Steam and vacuum brakes are applied to all driving wheels, while the truck at the firebox end has also a hand-brake for the coupled wheels. A steam sanding apparatus is applied, and the engine has an electric headlight and a speed indicator.

In the freight engine, the front truck and first driving axle of each group are equalized, while the second and third (main) driving axles and inner carrying or pony-truck axle form a separate equalizing system. This engine has an acetylene-gas headlight. A satisfactory distribution of weight is secured, so that even with both bunkers and tanks empty (which condition would not exist in service) there is ample weight on the pony-truck axles. The general dimensions of these two engines are given in the acompanying table.

The first Garratt engines used on the Tasmanian lines were for the Northeast Dundas branch, of 2-ft. gage, having maximum grades of 4%, and sharpest curves of 99-ft. radius. Each engine had two four-wheel trucks (with the cylinders at the inner ends), and weighed 33 tons complete. The ordinary engines on this branch were tank engines of the 0: 4: 2 type.

The Garratt Locomotive on Other Railways

Six locomotives of this type were built in 1911 for the Western Australian Government Railways (3-ft. 6-in. gage), and they proved so satisfactory that six additional locomotives (equipped with superheaters) were ordered and were delivered in 1913. Each truck has a 2: 6: 0 wheel arrangement, with the king-pin supports for the boiler frame between the second and third driving axles. These engines were designed to operate on grades of 4.5% with curves of 17°, and the axle load was limited to 9 tons. The dimensions of the engines are given in the accompanying table.

In addition to the Tasmanian and Australian railways noted, locomotives of the Garratt type have been built for the Darjeeling-Himalayan Ry., in India; the Arakan Flotilla Co., of Burma; the San Paulo Ry. and Mogyana Ry., of Brazil, and the Belgian-Congo Ry., of Africa. The Darjeeling Ry. (24-in. gage) is noted for its steep grades and its extremely sinuous location, including several loops. The engines have two four-wheel trucks (0: 4: 0—0: 4: 0), with the cylinders at the outer ends; they weigh 28 tons, and can traverse reverse curves of 60-ft. radius. The Congo Ry. engine (30-in. gage) has six-wheel trucks (0: 6: 0—0: 6: 0), with cylinders at the extreme outer ends connected to the inner driving axles. Oil fuel is used, carried in a cylindrical tank on the forward truck. The engine was built by the Société de St. Leonard, at Liége, Belgium, and was shown at the international exhibition at Ghent in 1913.

Designs have been made for a large standard-gage engine of the 0: 8: 0—0: 8: 0 class, with eight driving axles.

A Special Rail Section for Curves

An interesting development in railway-track construction is a so called "frictionless" rail designed to be used on the inside of curves. Its special feature is a very narrow head, and its purpose is to reduce the slip of the inside wheel, which takes place in compensating for the greater length of travel of the wheel on the outside rail. It is claimed that there is a diminution of friction and resultant wear to both the outer and inner (frictionless) rails and the wheel flanges; while the reduced friction gives a freer and smoother passage of the wheels, with a reduction in power required to handle a given tonnage. The rail is supplied by the Frictionless Rail Co., of Boston, Mass.

Other special rails for curves have been designed mainly to give additional metal available for wear. The Manning rail, tried some years ago on the Baltimore & Ohio R.R., had $\frac{1}{32}$ in. of additional metal on the inner side of the head and $\frac{1}{32}$ in. less on the outer side. The special 110-lb. rail of the Lehigh Valley R.R. (Engineering News, Oct. 24, 1912) has the head slightly wider and considerably deeper than that of the standard rail.

Southern Pacific Ry.

The Southern Pacific Ry. has ordered 5000 tons of the frictionless rail, using a 90-lb. section as a companion to the standard 90-lb. A. R. A. (A) type section, and for information as to this we are indebted to John D. Isaacs, Consulting Engineer, Southern Pacific Co. The rail is laid on 9° and 10° curves on single track, carrying heavy traffic. The track has 18 ties 7x9 in. to a 33-ft. rail length, the ties having tie-plates and being laid in a full bed of ballast. The rails are laid with suspended joints, 18 in. c. to c. of ties, and are spliced with 27-in. bars having four bolts (5½ in. c. to c.) with heads alternately on the inside and outside of the rail. This is the standard joint construction.

The rail has not been in service for a sufficient time to enable a definite statement to be made as to its performance, but we are informed that so far the reports are satisfactory. The sections of the standard and frictionless rail are shown in Fig. 1, while Fig. 2 shows the

taper rail for connecting the two sections at the ends of the curves. The dimensions are shown in the accompanying table:

Boston Elevated Railway

On the Boston Elevated Ry., the frictionless rail has been laid on several curves, ranging from 9° to 57°, the length of rail used being from 116 to 482 ft. The rail weighs 79½ lb. per yd. and is used with the 85-lb. Am. Soc. C. E. section. Both are of openhearth steel, treated with ferro-titanium, with chemical composition as follows: carbon, 0.80 to 0.95%; phosphorus, under 0.04%; silicon, 0.10 to 0.20%; manganese, 0.65 to 0.90%; metallic titanium, 0.10%; sulphur, 0.03 to 0.05%. For information as to the service we are indebted to H. M. Stewart, Chief Engineer of Maintenance-of-Way.

On account of the short length of these curves it has not been possible to obtain accurate tests as to the increase or decrease in power consumption used by a train in going around the curves, but it is known that less power is required than when the curves were laid with the 85-lb. rail. In some instances where power was required to pass a curve laid with the 85-lb. rail, it is now possible to coast through the curve. It is not found that the narrow-headed rail decreases the braking power of the trains. Practically all of the special rail is on the elevated structure where it is considered necessary to use a heavy guard rail, rigidly attached to the inner rail of the curve. Therefore, the results on this road may not conform with those obtained on steam roads where guard rails are not used.

As an example of the experience with this rail, the curve at Causeway and Haverhill St. may be taken. This has a radius of 90 ft. on the center line, and about 297 ft. of the frictionless rail was laid on the inside of the curve in 1912. The conditions on this curve have been as follows:

On the inside of the curve, the 85-lb. Am. Soc. C. E. rails of openhearth ferro-titanium steel were removed Nov. 16, 1912, after a life of 262 days, with a wear of 0.029 ft., being removed on account of corrugations. The 79-lb. "frictionless" rails of the same steel, laid on the above date, were examined on Aug. 26, 1913, after 283 days' service. The wear was 0.036 ft., while there was very little corrugation. The permissible amount of wear is 0.045 ft., and the life of this rail therefore was estimated at 354 days, or 35% more than the actual life of the former ordinary rails.

On the outside of the curve, the 85-lb. rail showed a wear of 0.039 ft. during the 262 days' life of the 85-lb. ordinary rail on the inside, while it was 0.040 ft. during the 283 days' service of the 79-lb. special rail.

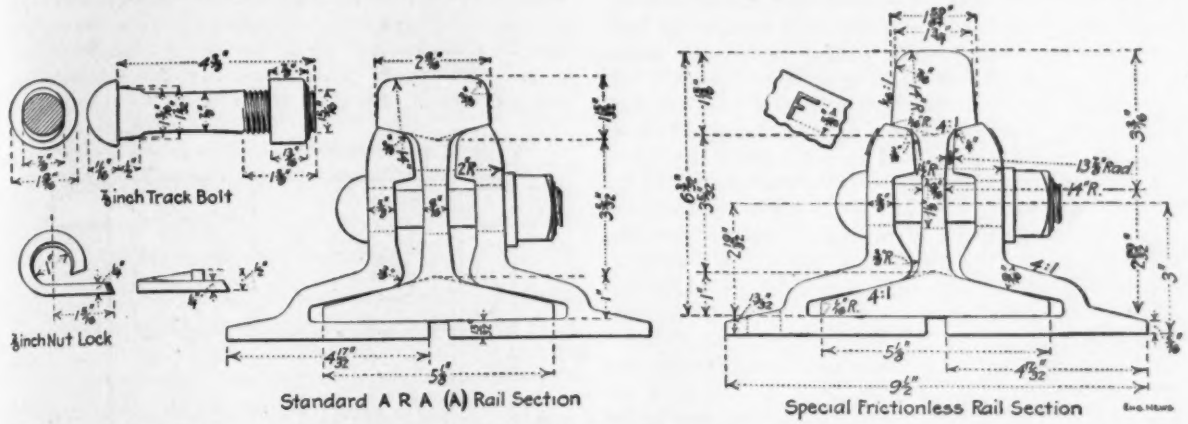


Fig. 1. Comparative Sections of the Standard 90-Lb. Rail and the Special "Frictionless" 90.29-Lb. Rail Used on the Inside of Sharp Curves; Southern Pacific Ry.

STANDARD AND SPECIAL RAILS FOR CURVES: SOUTHERN PACIFIC RY.

	A.R.A. (A)	Frictionless
Type of rail		
Weight, per yd.	90 lb.	90.29 lb.
Height	5½ in.	6 1/16 in.
Width of base	5½ in.	5½ in.
Width of head, top	.....	1¼ in.
Width of head, bottom	2 5/16 in.	1 13/16 in.
Side of head, slope	1/4 to 1	1/4 to 1
Depth of head	1 11/16 in.	1 11/16 in.
Depth of web	3 1/16 in.	3 1/16 in.
Depth of base	1 in.	1 in.
Thickness of web, middle	7/16 in.	7/16 in.
Thickness of flange, edge	½ in.	½ in.
Height to c. of bolt hole	2 11/16 in.	2 11/16 in.
Radius, top of head	14 in.	14 in.
Top corners of head	⅛ in.	1/16 in.
Bottom corners of head	1/16 in.	1/16 in.
Fillets	⅛ in.	⅛ in.
Corners of base	1/16 in.	1/16 in.
Sides of web	14 in.	14 in.
Edge of base	Vert	Vert.
Fishing angles	4:1	4:1
Area of head, frictionless, 3.229 sq.in.	36.2%	36.5%
Area of web, frictionless, 2.116 sq.in.	24.0%	23.9%
Area of base, frictionless, 3.507 sq.in.	39.8%	39.6%
Area, total	8.82 sq.in.	8.852 sq.in.
Moment of inertia	33.70	43.48
Section modulus, top	.....	16.67
Section modulus, base	.....	12.47
Height of neutral axis from cen. of bolt holes	0.05375 in. below	0.0145 in. above

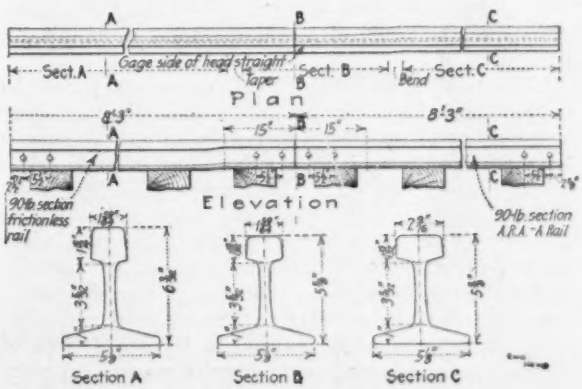


Fig. 2. Taper or Compromise Rail for Connecting the Ordinary and Special Rails at the Ends of Curves

The Wheeler Filter Bottom

By Robert Spurr Weston*

It has been clearly demonstrated by J. W. Ellms† at Cincinnati that the sand beds of mechanical filters can be most effectively cleaned by the application of wash-water at rates exceeding a vertical velocity, above the sand, of 8 mm. per second (18 in. per min.). Other engineers have confirmed the truth of Mr. Ellms' observations. Where lower velocities have been used, it has been necessary to agitate the sand during washing by means of revolving rakes, compressed air or other devices.

To make use of the higher velocities of wash-water, it has been the practice either to deepen the whole gravel layer of the filter or to hold in place the lower coarse layer (that immediately above the wash-water inlets) by means of suitable screens. When the bottoms of such filters consist of a series of troughs or inverted pyramids, the screens cover the depressions, but where a flat bottom is used special standards have to be provided. All of these arrangements are expensive and not in all cases satisfactory.

The disadvantages of existing arrangements led William Wheeler,‡ on June 29, 1907, to design an improved filter bottom. At that time his idea was to use it in connection with a filter plant in Kentucky. This work, however, was postponed and the device was not worked out until 1913, when the writer and his assistants experimented with it and later embodied it in the design of the filters at Belfast, Maine, recently put into operation.

Mr. Wheeler's original design (Fig. 1) consisted of a series of concrete inverted pyramids, spaced 1 ft. c. to c. At the bottom of each pyramid is a 0.75-in. tube which serves both as filter outlet and wash-water inlet. There is nothing particularly novel in the so called hopper bottom; it has been used in water filters for many years, notably at the plant of the Hackensack Water Co., at Milford, N. J.§

Hitherto all filter bottoms with depressions, pyramidal or prismoidal, have been provided with strainers of some sort and have been filled either with uniform or ununiform material placed at random—for example, shot, quartz, gravel, rods, etc. The Wheeler filter bottom effectively overcomes the objections to previous designs and differs from them in that it substitutes for a wash-water distributing layer placed at random, an assembly of distributing elements in the form of true spheres of cement, earthenware or other suitable material. In other words, it substitutes for a random layer a system of spheres arranged according to definite mechanical principles. These make use of the adhesive force between the water on the one hand and the spheres and the slopes of the inverted pyramids on the other, effecting a nearly perfect distribution of wash-water, so that it leaves the tops of the pyramids with a nearly uniform vertical velocity. It does this without allowing any of the sand to work down into the voids between the spheres, and at the same time it renders available substantially the entire top of the depression to collect and discharge the filtered water.

The ball nozzle is an example of the action of the sphere on the jets issuing from the bottom of each pyramid during washing. It is a well known fact that a solid sphere is the geometrical form having the greatest weight in proportion to its surface. Therefore, it presents a form which has the greatest weight with the least surface friction. The form and the surface of the spheres, therefore, makes them least liable to disturbance by the upward flowing stream of wash-water. In fact, they will not move with wash-water velocities of less than 25 mm. per sec. (5 ft. per min.) even when uncovered with gravel. This immobility of the spheres allows the use of very thin gravel layers to support the

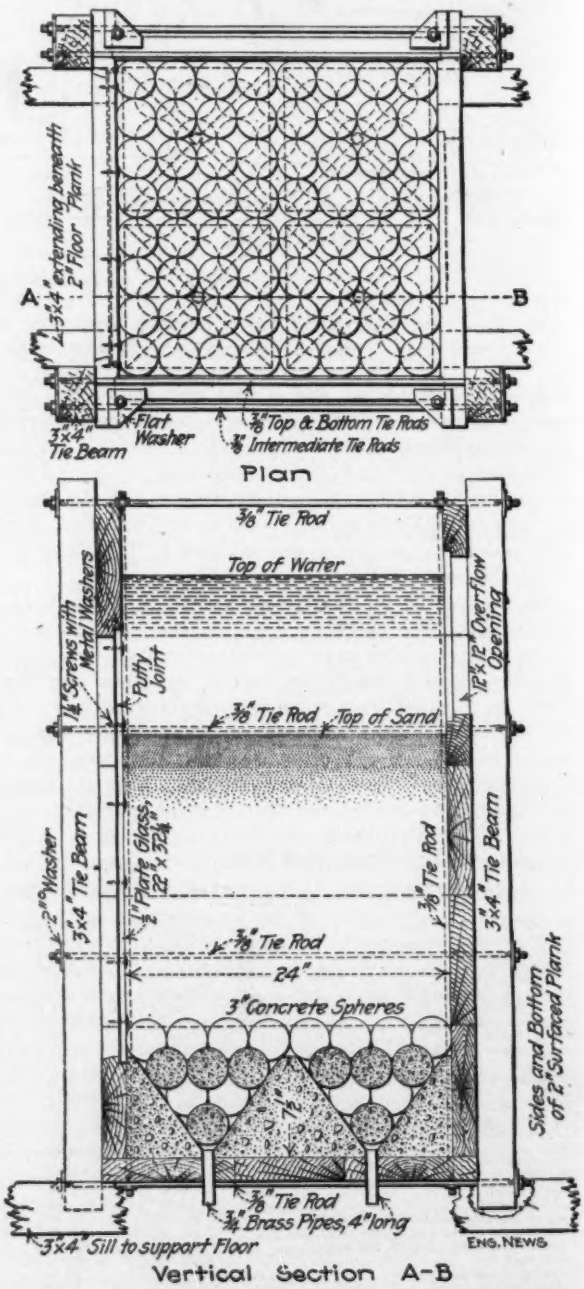


Fig. 1. Wheeler Filter Bottom in Concord Experimental Filter

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§"Engineering Record," Vol. 50, p. 572.

sand layer—thereby reducing the thickness of the underdrain system and the cost of construction.

Design of the Filter Bottom

Mr. Wheeler's original design was as follows: Directly over each wash-water inlet was placed a 3-in. sphere molded of Portland cement; over the first sphere were placed four others; over these four, nine; and over these nine, twelve more—making a system of 30 spheres arranged like an inverted pile of cannon balls.

Experiments showed that this first design was unnecessarily refined. Accordingly, the number of 3-in. balls was reduced from 30 to 5, and above these were placed nine glazed, earthenware marbles, eight of which had a diameter of 32 mm., and one (the center one) a diameter of 40 mm. Above this system of spheres were placed three layers of gravel. These layers may be surprisingly thin without allowing any of the sand to escape during filtering or any mixing of it with the gravel during washing. In the plants in practice a layer 6 in. in thickness has been used, but the writer feels reasonably sure that a 3-in. layer would satisfy all requirements, so good is the distribution of wash-water and the grading of the gravel layer. The inverted pyramids are truncated and their sides do not meet to form a sharp edge.

Experiments—Preliminary to designing the new filters for the Belfast (Maine) Water Co., Mr. Wheeler and the writer conducted a series of experiments at Concord, Mass., with a small observation filter.

Filter—The filter is practically that shown in Fig. 1. It had an area of cross-section of 4 sq.ft. and four ¾-in. effluent tubes were connected by means of reducing fittings and 1½-in. pipes with an adapter, the latter connecting with the 2½-in. hose to the hydrant. With this arrangement it was possible to maintain a vertical velocity of 25.2 mm. per sec., equivalent to about 5 ft. per min.

Sand—Five different kinds of sand were used. Two, from Concord, Mass., were bank sands, and three were beach sands from the Massachusetts coast. The results of mechanical analyses of samples of these sands, taken after they had been in use, are shown in Table I.

TABLE I. MECHANICAL ANALYSES OF FILTER SANDS

Sand No	Kind	Lab. No.	10% finer than	60% finer than	Uniformity coefficient
1	Concord	348	0.49	0.94	1.92
2	Concord	355	0.33	0.47	1.42
3	Plum Island	363	0.53	0.79	1.49
4	Salisbury Beach	370	0.40	0.60	1.50
5	Ipswich	377	0.26	0.44	1.69

Gravels—Three grades of gravel were used to support the sand. This gravel was screened from Concord sand No. 1 and separated into three grades, first that passing a coarse screen having 1 in. square meshes and retained on one having ⅜-in. square meshes, second that passing through a screen having ⅜-in. square meshes and retained on one having ¼-in square meshes, and third that passing through a screen having ¼-in. square meshes and retained on one having 12 meshes per lin.in. Two of these gravels were subjected to mechanical analysis (see Table II).

TABLE II. MECHANICAL ANALYSES OF FILTER GRAVEL

Sample	Lab. No.	10% finer than	60% finer than	Uniformity coefficient
Medium	383	12.5	18.0	1.44
Fine	384	2.36	2.60	1.10

Cement Balls—The 3-in. cement balls used to fill the pyramids were made in the laboratory from neat Portland cement. Their specific gravity was 2.4.

Marbles—The marbles used to fill the interstices between the cement balls were ordinary German, blue agate marbles—that is, cheap glazed earthen ware. They averaged 1.2 in. in diameter, and had a specific gravity of 2.84.

Trials

Trial No. 1—The first trial was made with each pyramid filled with four layers of concrete balls, that is, 30 balls to a pyramid. The interstices between the balls at the surface were filled with 25 marbles.

Water was applied to this system of balls and marbles at the rate of 25 mm. per sec. without disturbing the position of the marbles.

Trial No. 2—In this trial the upper layer of balls was removed, leaving the first 14 balls in each pyramid arranged in three layers. These balls could not be displaced with the velocity available, and 16 marbles were placed in the interstices at the surface. Table III gives the results of observations at different velocities:

TABLE III. RESULTS OF TRIAL NO. 2 WITH THREE LAYERS OF BALLS, AND ONE LAYER OF MARBLES, AND WITH AND WITHOUT GRAVEL LAYERS

System	Vertical velocity mm. per sec.	Vertical velocity ft. per min.	Results
A—Balls and marbles only.	8.0	1.6	No movement
	20.0	4.0	No movement
	21.8	4.3	No movement
	22.6	4.4	Marbles revolve
	23.5	4.6	Marbles revolve
B—Like A with 2 in. of ⅜ to 1 in. gravel.	12.7	2.5	No movement
	24.4	4.8	No movement
Level of gravel was 1 in. above tops of balls.	24.6	4.8	No movement
C—Like A with 1 in. of ⅜ to 1 in. gravel, 1.5 of ¼ to ⅜ in. gravel.	24.6	4.8	No movement
D—Like A with 0.3 ft. of graded gravel.	20.0	4.0	No movement
	24.6	4.8	No movement

Trial No. 3—Trial No. 3 was similar to Trial No. 2, with the exception that fine gravel of two different thicknesses, namely 0.1 and 0.3 ft., was placed above the coarser graded gravel.

When the finer layer (*A*) was used, most of the movement took place around the periphery of the filter and at the corners of the pyramids. The lift or boiling in the center of each pyramid was less than around the periphery but was in spots, and always in the same spots. With velocities below 18 mm. per sec., equivalent to 3.5 ft. per min., the fine gravel was undisturbed. With higher velocities there was a slight movement.

With the thick layer of fine gravel, the surface was lifted at two spots from 0.2 to 0.3 ft. above its average elevation.

The results are summarized in Table IV (p. 24).

Trial No. 4—Trial No. 4 was made with two layers of balls and one layer of marbles; that is, four marbles and nine balls in each pyramid. In addition to the balls, gravel layers of various thicknesses were tried.

It will be noticed that when balls and marbles alone (*A*) were used, a velocity of 10.7 mm. per sec. caused the corner marbles to revolve slowly. When the velocity was increased to 16 mm. per sec., the side marbles revolved; the corner marbles were lifted one-half way to the top of the pyramid, while the center marble remained stationary. When the velocity was increased to 17.9 mm. per sec., a large percentage of the corner marbles was lifted nearly to the top of the pyramid and all of the marbles except the center ones were moved.

TABLE IV. RESULTS OF TRIAL NO. 3 WITH THREE LAYERS OF BALLS, ONE OF MARBLES AND VARIOUS GRAVEL LAYERS

System	Vertical velocity mm. per sec.	Vertical velocity ft. per min.	Results
A—With 0.3 ft. graded gravel and 0.1 ft. fine gravel.	12.7	2.5	No movement
	16.9	3.3	No movement
	17.9	3.5	No movement
	20.3	4.0	Slight movement at edges
	21.8	4.3	Slight boiling
	22.0	4.3	Boils and expands 0.5 in.
	23.5	4.6	Boils and expands 0.5 in.
B—With 0.3 ft. graded gravel and 0.3 ft. fine gravel.	12.7	2.5	No movement
	17.9	3.5	Very slight boiling
	19.3	3.8	Very slight boiling
	20.3	4.0	Boiling around edges of pyramids. Whole surface boils, but the motion is greatest above the junctions of the pyramids.
	23.5	4.6	
	24.2	4.8	
	25.0	4.9	

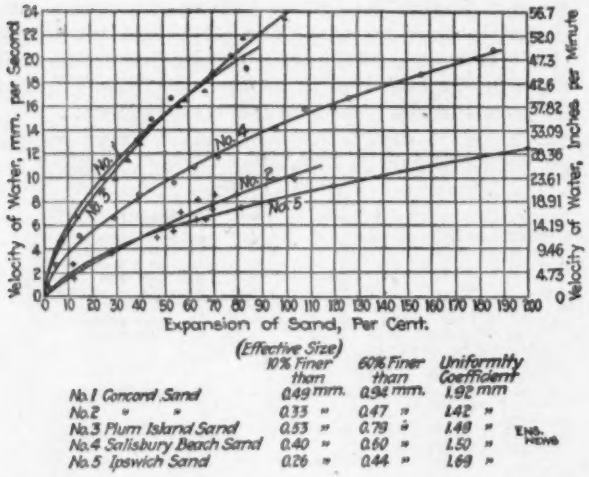

Velocity of Water, mm. per Second
Velocity of Water, Inches per Minute
Expansion of Sand, Per Cent.
No. 1
No. 4
No. 3
No. 2
No. 5
(Effective Size)
10% Finer than
60% Finer than
Uniformity Coefficient
No. 1 Concord Sand 0.49 mm. 0.94 mm. 1.92 mm
No. 2 " " 0.33 " 0.47 " 1.42 "
No. 3 Plum Island Sand 0.53 " 0.79 " 1.49 "
No. 4 Salisbury Beach Sand 0.40 " 0.60 " 1.50 "
No. 5 Ipswich Sand 0.26 " 0.44 " 1.69 "
ENG. NEWS

FIG. 2. RELATION BETWEEN UPWARD VELOCITY OF WASH WATER AND EXPANSION OF SAND IN MECHANICAL FILTER

With the highest velocity, 25 mm. per sec., the action was similar to that observed at a lower velocity. A larger percentage of the marbles, however, was lifted to the tops of the pyramids. With the velocities available none of the marbles could be washed from one pyramid into another. It is doubtful if this could be brought about even with a considerably higher velocity.

When coarse gravel was used (*B* and *C*) there was no lifting of the gravel, but only when fine gravel was used (*D* and *E*) was the gravel disturbed in some cases and expanded by the action of the water according to the velocity.

The results of these experiments are shown in Table V.

TRIAL NO 5—Trial No. 5 was made with the same system of balls and marbles used in Trial No. 4. Above this was placed the following arrangement of gravel: 1.5 in. coarse gravel, ⅜ to 1 in.; 1.5 in. medium gravel, ¼ to ⅜ in.; 3 in. fine gravel, No. 12 mesh to ¼ in. Above the gravel was placed 12 in. of one of the various sands described above.

The action of the gravel and sand layers during Trial No. 5 was all that could be desired. In no case was the gravel disturbed and the sand was uniformly expanded

Analyses of these various sands have showed how complete was the separation of the sands into sizes by the process of washing. They also indicated considerable variation in uniformity. For example, the Concord sand to a degree dependent upon its size and the vertical velocity of the wash-water passing through it. It is believed that even a considerably thinner layer of fine gravel could be used in practice than the 3-in. layer used during the experiments, and with equally good results.

TABLE V. RESULTS OF TRIAL NO. 4 WITH TWO LAYERS OF BALLS, ONE LAYER OF MARBLES, AND VARIOUS GRAVEL LAYERS

System	Vertical velocity mm. per sec.	Vertical velocity ft. per min.	Results
A—Balls and marbles	12.7	2.5	Marbles revolved slowly
	16.0	3.2	Marbles moved (1)
	17.9	3.5	Marbles moved (2)
	25.0	4.9	Marbles moved (3)
B—Like A with 1 in. of ⅜ to 1 in. gravel.	13.4	2.6	No gravel lifted
	17.7	3.5	No gravel lifted
	21.8	4.3	No gravel lifted
	25.0	4.9	No gravel lifted
C—Like B with 1.5 in. of ⅜ to 1 in. gravel and 1.5 in. of ¼ to ⅜ in. gravel.	16.6	3.3	No gravel lifted
D—Like C with 1 in. of No. 12 mesh to ¼ in. gravel.	13.1	2.6	No gravel lifted
	14.9	2.9	No gravel lifted
	17.5	3.4	Slight boiling
	21.8	4.3	Gravel expanded ¼ in.
	25.0	4.9	Gravel expanded ½ in.
E—Like D with fine gravel layer increased to 3 in. in depth.	12.7	2.5	No gravel lifted
	16.0	3.2	No gravel lifted
	17.9	3.5	No gravel lifted
	20.3	4.0	Slight lifting of gravel more marked at periphery of filter
	21.8	4.3	
	25.4	5.0	Gravel boils gently

(1) Side marbles revolving, corner marbles lifted half way.
(2) Side and center marbles revolving, corner marbles lifted half way.
(3) Side marbles lifted half way, corner marbles lifted to top.

SORTING OF THE SAND PARTICLES BY WASHING—After the trials with each kind of sand had been made, samples were taken for mechanical analysis, from the surface of the sand layer and from various depths below its surface.

No. 1 varied in size between the surface and the bottom of the sand layer from 0.25 mm. to 0.84 mm. effective size, while the Ipswich sand varied only from 0.21 mm. to 0.31 mm.

The summarized analyses also showed how the effective size of the sands might be markedly altered by scraping the surface of the same after washing. For example, by scraping 1 in. from Concord sand No. 1, after washing, the effective size could be increased from 0.25 to about 0.45 mm.

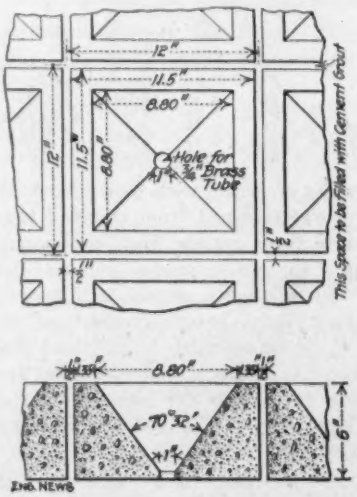


FIG. 3. PYRAMIDAL FILTER BOTTOM UNIT FOR THE MECHANICAL FILTER PLANT, BELFAST, ME.

EXPANSION OF SAND—Many data were obtained during these experiments which had reference to the sand and not to the filter bottom. Fig. 2, showing the relation between the upward velocity of the wash-water and the percentage expansion of the five sands as observed during

the experiments, is of interest in this connection.

To determine the degree of expansion the sand layer was measured before and after washing and the average elevation of the surface of the sand during washing was estimated as accurately as practicable.

It will be noted that the degree of expansion for any given velocity of water varies not only with the effective size of the sand but also with the shape and character of

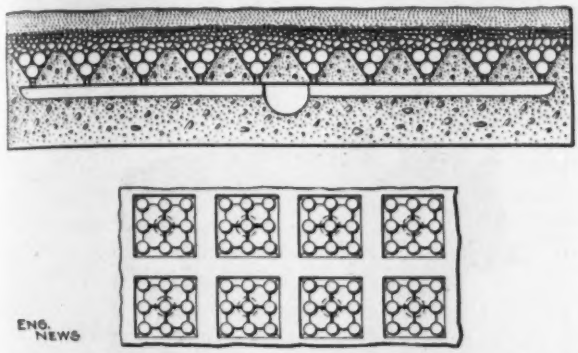


FIG. 4. DESIGN OF WHEELER FILTER BOTTOM AS SHOWN IN PATENT APPLICATION

the sand grains themselves. Consequently, two sands of different sizes and uniformity, like Nos. 1 and 3 and 2 and 5, respectively, show similar degrees of expansion with various velocities of wash-water. Still greater variations could be expected if the sand contained mica, limestone or other minerals varying in shape, specific gravity and structure.

The effective size of the sand, that is, its 10% size, is of especial value for determining the friction of the sand layer when water is being filtered through it. For estimating the friction during washing, the average size of the particles is of far greater importance. The value nearest the average size which is given by the ordinary sand analysis is the 60% size, that is, the size when 60% of the sand is finer than any given diameter.

The uniformity coefficient of the sand layer affects its hydraulic value and also the degree of expansion of the sand layer with varying velocities of wash-water (Fig. 2).

In addition to the above trials, the optimum velocity of wash-water for each of the five sands used was determined; also the percentage expansion of each sand when washed at the optimum velocity. Other experiments were also made but like the ones just mentioned they had no reference to the design of the filter bottom, although its precise action made the results of filter-sand experiments of greater value than usual.

RESULTS IN PRACTICE

The filters at the Belfast Water Co., mentioned above, have been in operation a very short time. Nevertheless, there is no reason to believe but that they will continue to operate as efficiently in the future as they do at present. Since the Belfast filters (Fig. 3) were designed, Frank A. Barbour, of Boston, Mass., has embodied the Wheeler filter bottom in the design for the new water-purification plant for the city of Akron, Ohio, and negotiations are now in progress for its use in a still larger plant.

To protect the design (Fig. 4), patents were applied for on June 26, 1913.

The Gatun Hydro-Electric Plant, Panama Canal*

The following particulars of the hydro-electric plant at Gatun Dam are of interest on account of the part of this station in the general canal development and because of the various features themselves. The project for the use of electric energy in various services in connection with the operation of the Panama Canal has been noted from time to time in ENGINEERING NEWS as the plans developed (and were summarized in an article on the lock-control system, Dec. 25, 1914).

The Gatun Lake storage offers good opportunity to generate current for lighting the canal, for operating the gates and other locking machinery, for the towing locomotives, for coal-handling plants at both ends of the canal, for machine shops, water-works, dry docks, and possibly in the future for hauling trains on the Panama Railroad.

The Gatun plant has a present capacity of 6000 kw and this can be increased to 12,000 kw. if advisable, outlet pipes having been installed in the dam along with the original pipe lines. (To insure continuity of service in case of accident, a 4500-kw. steam-electric station at Miraflores, erected a few years ago to supply power for construction work, will be ready to pick up the load when necessary.)

OPERATING HEAD AND INTAKE—The gross head available from Lake Gatun to mean-tide level of the Pacific Ocean varies from a maximum of 91 ft. in the extreme flood times to a minimum of 79 ft., to which level the lake may possibly drop toward the close of the dry season. The plant is designed consequently to develop full capacity under an effective head of 75 ft. For three or four months of every year there is absolutely no rainfall on the Isthmus; and during this period, it is desirable to conserve the water to as great an extent as possible. Maximum efficiency was therefore demanded for the apparatus of both the waterwheel and generator manufacturers. As shown in Fig. 1, in the masonry at one side of the Gatun dam spillway, are six 12-ft. passages protected with iron trash racks. Only three pipe lines have been put in with their headgates 10½ ft. in diameter.

Each gate has two steel stems with bronze nuts in roller bearings; each pair of nuts is driven through bevel gears by a 15-hp. motor. Hand-operating mechanism is disconnected during power operation (two men are required to open).

The gates have an automatic control consisting of a limit switch geared to one of the gate stems and a float switch actuated by the water in the pipe. The gate-motor switch is closed at the power house, the gate being closed and the pipe line empty. When the gate has opened a distance which would fill the pipe line in about five minutes, the limit switch opens the circuit and stops the motor. When the pipe line is filled and the water rises in the 36-in. vent just below the gate, it actuates a float switch and again closes the motor circuit, thereby causing the gate to be opened fully, when the limit switch again operates to prevent over-travel. The gate is closed by reversing the main switch.

PIPE LINES—Each gate is bolted to a steel pipe line 10 ft. 6 in. in diameter with an average length of 420 ft.

*From information furnished by the General Electric Co., Schenectady, N. Y.

The pipes are of 3/8-in. plate, courses 8 ft. long and three sheets around the circumference. Each course has a center ring of 3/8x3-in. Z-bar. The pipes are covered with reinforced concrete as rust protection. They come down on a uniform slope and turn under the station with 90° bends of 70-ft. radius. Each pipe is arranged for Pitot-tube tests in service.

Each pipe has two 6-in. saddle-nozzle connections located 45° on each side of the vertical center line of pipe. From these connections there are two Pitot-tube guide supports placed across the pipe at right angles to each other. These are bolted in the pipes and, while intended to be permanent, can be removed readily if desired.

STATION BUILDING—The principal buildings are designed along simple lines in harmony with the unbroken surfaces of concrete of the adjacent engineering works. For the same reason they are devoid of all modeled ornament; the plain wall surfaces are relieved only by the base moldings, cornices and the architraves bounding the openings. This has the effect of enlarging the apparent size of the buildings, though they must appear dwarfed by proximity to large masses of concrete.

The station building is 61x137 ft. and 74 ft. high. There is a single room open to the roof, exposing the trusses upon which is laid the reinforced-concrete roof slab, which, in turn, receives the red Spanish tiles. The walls are of poured concrete, 30 in. thick to the level of the crane rails, near the cornice. The exterior overhang of the main roof is 13 ft. 2 in. and that of the monitor roof 4 ft. 8 in., the exceedingly large projections having been generally adopted for all the permanent buildings in the Canal Zone as a shelter from tropic rains, as well as from the heat of the sun.

Beyond the general use of tile for flooring, and an interior white enameled brick wainscot 14 ft. high, to relieve the coarseness of the walls, there is no difference in the finish of the concrete surfaces within and without. There are four principal interior elevations: (1) turbine electrical equipment, etc., and the other as an uninterrupted passage along the line of turbines; (3) a mezzanine gallery reached by concrete stairways at the building ends; (4) a second gallery which with the mezzanine carries the switches, reactances, control boards, etc. These run the entire length of the building; in one corner are two superimposed galleries, one used as an office and the other as a machine shop.

TURBINES—The three 2000-kw. main generating units

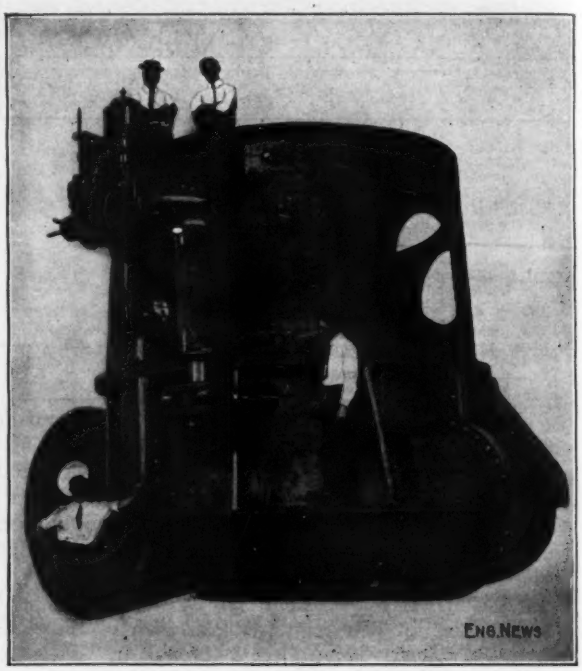


FIG. 2. SPIRAL CASING FOR FRANCIS TURBINE, DISTANCE RING AND GOVERNOR

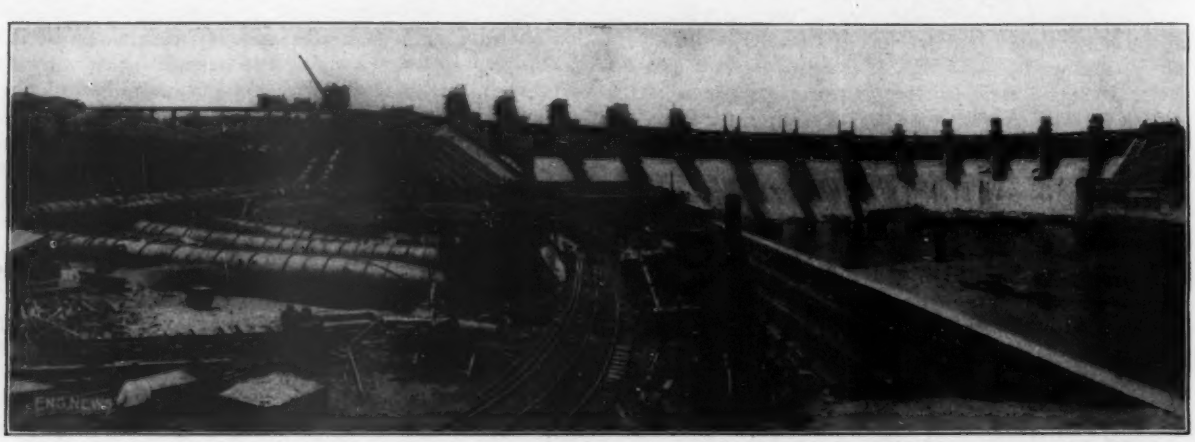


FIG. 1. PANORAMIC VIEW OF HYDRO-ELECTRIC STATION WITH PENSTOCKS AND SPILLWAY FOR MAIN DAM; GATUN LAKE, PANAMA CANAL

pit, with an area of 2100 sq.ft., 6 ft. below the main floor and reached by iron stairs; stairs also descend from the pit to store, compressor and pump rooms. The pit is lined with white enameled brick. Between pit and main-floor levels are the toilet rooms—separate accommodations for black and white employees; (2) the main floor, partitioned off to give two main parts—one for various

in the hydro-electric station are each driven by a special, 50-in., vertical, single-runner, Francis turbine. Each has a maximum capacity of 3600 hp. when operating under an effective head of 75 ft. and at a normal speed of 250 r.p.m. The center of the runners is 20 ft. above tail water.

Water is discharged through steel-lined (1/4-in. plate)

concrete draft tubes, which are 71 in. in diameter at the discharge from the runners and increase to an elliptical section of 9 ft. by 17 ft. at horizontal outlets.

The spiral casings carry the generator frames through cast-iron distance rings (Fig. 2). A roller thrust-bearing on top of the generator frame carries the load of revolving parts (32 tons); at full capacity on upward thrust of 20,000 lb. relieves the bearing. Geared to the main shaft is a small oil pump for the thrust-bearing; the returning oil lubricates the lower guide.

The turbine runners (weight 7000 lb.) are of bronze, hand finished, bored taper and held on the shaft by bronze nuts. The wicket gates are steel castings, hand finished; the pivot stems rise through glands to levers. The levers are linked into the gate ring and the whole gear is outside the turbine casing except the gates proper. Oil-pressure governors are provided, geared to the main shaft. Small motors permit remote control of governor setting to vary speed for synchronizing.

GENERATORS—The main generators are of a three-phase 25-cycle revolving-field type developing 2000 kw. at 0.8 power factor, 2200 volts and 250 r.p.m. They have 25% two-hour overload rating.

The exciter is mounted below the main generator but is readily accessible through large holes in the distance ring, a platform being provided inside the ring from which the exciter commutator and generator-collector rings may be reached. All windings were made moisture proof on account of extreme climatic conditions. Provision is made for securing the magnet frame of the exciter to the revolving element of the generator, so that the complete rotating element, together with the exciter frame, is raised at once in disassembling. In addition, there are two motor-driven exciters.

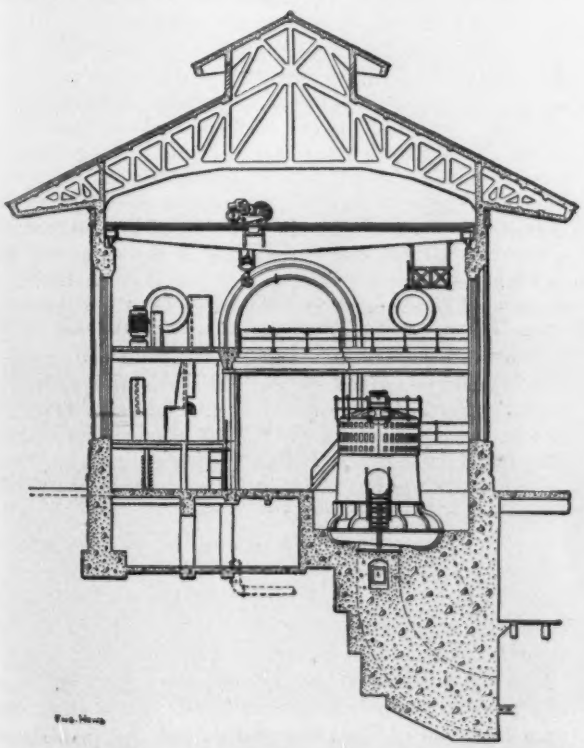


FIG. 3. SECTIONAL ELEVATION OF GATUN STATION

The official tests showed generator efficiencies (at 0.8 power factor) of 95.1% at 2000 kw., 94.3% at 1500 kw., and 92.5% at 1000 kw.

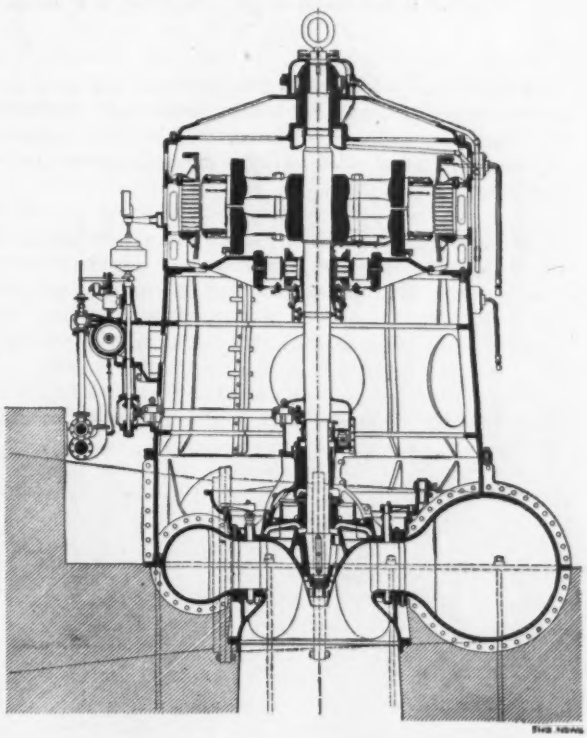


FIG. 4. SECTION THROUGH TURBINE GENERATOR AND EXCITER, GATUN HYDRO-ELECTRIC STATION

SWITCHBOARDS—Current is transmitted at 44,000 volts, but the step-up transformers are not in the main stations. The connection schemes throughout follow a double-bus, double-switch scheme as being most flexible for uninterrupted operation during repairs. The main switchboard comprises a control bench and a vertical rear panel for relays, uniters, etc.; a second story houses the motor-operated rheostats.

The complete hydraulic equipment was designed and built by the Pelton Waterwheel Co., of San Francisco; the electrical apparatus was designed and built by the General Electric Co. All details of design and construction were subject to the requirements and approval of the engineers of the Isthmian Canal Commission.

Structural Steel Frames or very considerable size and complication of design are being used in Europe as hangars for large dirigible balloons. In "Le Genie Civil," May 23, 1914, there is an extended article describing some typical sheds in use in France and Germany. In general these sheds consist of a series of simple arch frames, similar in design to the usual armory roof in this country but of much lighter material because of the very light roofing. They are usually rectangular in plan, providing room for one airship with exit or entrance at either end, but some of the newer sheds are wide enough for two airships, side by side, and proposals have been made to build them in triangular or in starshape plan, so as to provide entrance in the direction best favored by the prevailing wind. To accomplish this latter end, at least one shed has been built, 443x85 ft. in plan, mounted on a turntable so that it may be turned to meet any wind condition.

The Design and Construction of Sanitary Sewers, Carlisle, Penn.

By C. A. Bryan*

SYNOPSIS—This article is published not because it describes anything novel but rather because it illustrates the opposition and delays encountered and the methods commonly followed establishing a sewerage system for a small town.

The borough of Carlisle, Penn., has a population of about 10,000, is of slow growth and is considered very conservative. That the majority of the younger generation realize the necessity of improvements is evident but their influence is far outweighed by the majority of their elders who are opposed to improvements of any nature.

Sewerage was agitated in Carlisle as far back as 1905, at which time Chauncey Ives, Chief Engineer for the Cumberland Valley R.R., was consulted and prepared an estimate of the cost of sewering the town. No further definite action was taken until 1907-08, when T. Chalkley Hatton, Consulting Engineer, of Wilmington, Del., was instructed to prepare plans and specifications covering the proposed work. Plans were submitted in 1908 and approved by the Borough Council and a special election authorized to determine by popular vote whether the system should be constructed. The proposition was defeated. At the expiration of two years, the time specified in the act of assembly regulating elections of this nature, a second election was held, and the sewerage system was authorized. Exceptions to the result of this election were taken, a bill in equity filed and an injunction restraining the borough from proceeding with the work was issued. The case was carried up to the Supreme Court of the State and was finally decided in favor of the borough. The work was therefore advertised in March, 1913, the contracts signed and construction work started in April, continued through the summer, and the system finally finished during March, 1914.

Photographs, here reproduced as Figs. 1 to 4, were taken for the purpose of demonstrating the need for a sewerage system. These views were not taken to present the worst phase of the question, but to show that sewerage was unquestionably necessary.

Fig. 5 is a plan of the borough, showing the layout of the streets and the sewer lines. Elevations of the street surfaces and of the inverts of the sewers are given at all street intersections [but not all elevations are reproduced.—Ed.]. The city is divided into two natural drainage areas by the two principal streets, Hanover and High, as the ground falls to the east and west of Hanover St. and also to the north and south of High St.

After considerable study it was determined that the entire sewage of the town could be collected by two intercepting sewers, one to carry the sewage from the northern portion of the city and the other to carry that from the southern section, as shown by the map. For convenience in handling, the city was then subdivided into five sections—each being sewered by a main branch line which joined either one or the other of the two intercepting sewers.

From the company supplying the city with water, what information relative to the total water consumption of the city that they could furnish, was obtained. This information was at best very approximate inasmuch as the company had no accurate records. It was estimated that the average per capita consumption per day would amount to 100 gal., and the system was designed on this assumption.

The minimum velocity of flow of the sewage through the mains was fixed at 3 lin.ft. per sec., and the grades determined in accordance therewith. The topography was such that this velocity could be obtained without undue expense and in only a very few instances was it necessary to resort to the minimum velocity of flow.

It was assumed that the rate of increase in the population of Carlisle would be 500 per year (considerably greater than in the past), and it was also assumed that the system will serve 25,000 people, or more than double the present population of the borough. Allowance was made for an infiltration of ground water into the system amounting to 5000 gal. per mile of sewer per day.

The sizes of the various mains were then computed, profiles of each sewer were made, and an estimate of the cost of the lateral sewerage system computed.

In designing this system, careful attention was given to both the matter of cleaning out the mains and to their ventilation. The former was accomplished by placing the manholes at a distance of not over 250 ft. apart, and the latter by providing eight holes, each 6x1 in. in size, in the center of the cast-iron manhole covers. To prevent dirt and other foreign matters from getting into the sewers through these holes galvanized-iron catch buckets were hung in each manhole frame just under the cover. At the dead ends of all sewers, flush tanks were placed and at each flush tank a lamp hole was built, thus providing a method whereby the sewer barrel between the flushtank and the next manhole downstream could be easily examined. Each flushtank was designed to introduce a flush of 190 gal. into the sewers. Miller siphons 5 in. in diameter were specified and it was decided that the tanks would operate twice in 36 hours when put into service.

The specifications also provided that previous to the final acceptance of the system by the engineer each section of sewer should be tested by the passage through it of a ball whose diameter was to be 2 in. less than that of the sewer itself. The testing of the entire system of lateral sewers was put under the supervision of one of the inspectors well qualified for this work and a resident of the city. The city is thereby assured that the sewers when taken over were practically clean.

In computing the cost of construction, it was quite necessary to obtain an approximate estimate of the amount of rock to be removed. This was accomplished by taking a boring at each street intersection and also at a point in the middle of each block. These elevations were then plotted upon the profiles and the quantity of rock estimated.

*Resident Engineer, Sewerage Commission, Carlisle, Penn.

It was estimated that the lateral system would cost $49,600 to construct.

Bids on this work were asked for in March, 1913, and the lowest bid for the construction of this portion of the system was submitted by the H. C. Brooks Co., Inc., of Martinsburg, W. Va., and the work was awarded to it. Construction work was started early in April and continued through the summer and up to February, 1914, when bad weather set in just after the last block of sewer had been laid. During construction nothing especially difficult was encountered, the contractor finding but little ground water to contend with, and fully 80% of the work was laid in dry trench. More rock was encountered than was estimated and as it was all limestone and very hard to remove, progress was slow. In most of the alleys in which sewers were built, progress was also slow because of the extreme narrowness of these alleys, a fact which made it difficult to take care of the materials excavated from the trench. This was especially true in those alleys in which the cut was deep.

In general, the earth excavated was of a clayey composition and the sides of the trenches did not require much shoring. In those ditches in clay, where the cut exceeded a depth of 9 ft., considerable difficulty was experienced. In one stretch where the ground appeared to be of a character similar to that encountered in the other portions of the town, it proved very treacherous and caused no end of trouble. The material seemed to pulverize upon exposure to the atmosphere and was constantly falling upon the workmen in a sort of fine shower, and it

VIEWS TAKEN FOR USE IN CAMPAIGN TO SHOW THE NEED FOR SEWERS IN CARLISLE, PENN.

(Fig. 1. Cesspool back of laundry. Fig. 2. Laundry wastes from overflowing cesspool. Fig. 3. A Main St. eyesore, but common to whole town. Fig. 4. Alley in east end of borough.)

was soon shown that the only way to prevent this was to sheet the ditch throughout.

The futility of attempting to execute work of this size by using local labor was well illustrated at Carlisle. The contractor experimented with local labor for fully two months and was able to complete only about 1.5 miles of sewer in this time. Local labor was therefore discarded and foreign labor imported and retained on the work until it was completed.

The final estimate given the contractor shows that a total of 7.3 miles of 8- to 18-in. vitrified-pipe sewers have been constructed at a cost of $71,085, or $9739 per mile of completed sewer. The increase of approximately $20,000 in excess of the estimated cost is due principally to the fact that the rock encountered exceeded by nearly 50% the quantity estimated. This unexpected increase in the rock excavation cannot be laid to the engineer, for his preliminary investigation was carried on much more carefully than was warranted by the amount paid him by the town for his services.

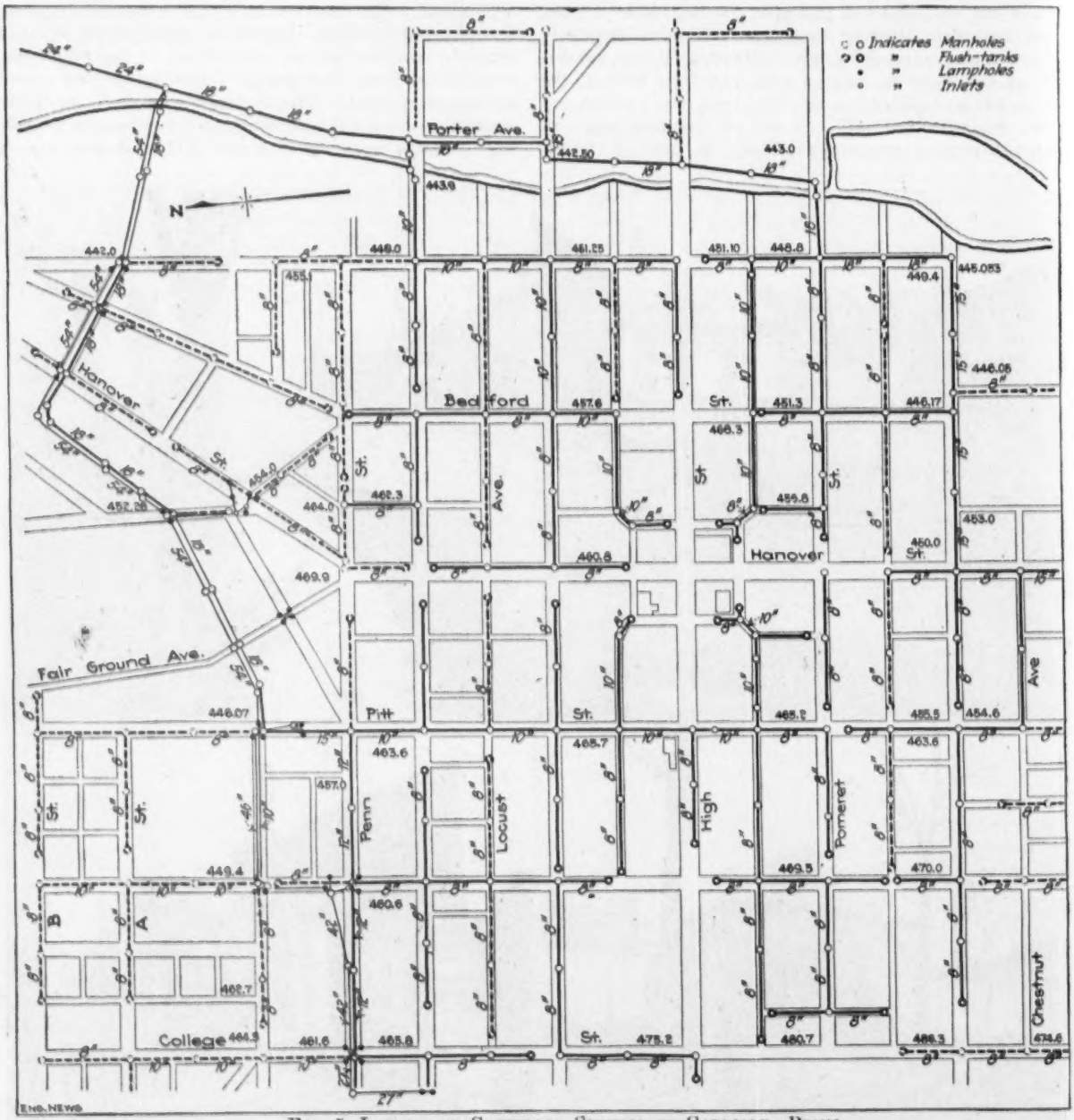


FIG. 5. LAYOUT OF SEWERAGE SYSTEM OF CARLISLE, PENN.

(Only a few samples of the figures showing grade elevations are here reproduced.)

The cost of constructing this system of sewers will be borne by an assessment levied upon abutting property owners on the basis of $1.30 per front foot. In the case of corner lots where sewers have been constructed on two sides, the assessment on the street on which the property fronts will be the same as in any other case, while

for the computation of the assessment on the other frontage, distances up to 130 ft. will be divided by two and the quotient assessed on front footage at the rate adopted. In cases where the distance on the side exceeds 130 ft., 65 ft. will be deducted from the total side distance and the remainder assessed as front footage. A survey of the town showed that a total of 60,000 lin.ft. was assessable. The rate quoted above was determined on this basis.

This sewer system was designed by and installed under the supervision of T. Chalkley Hatton, now Chief Engineer of the Milwaukee Sewerage Commission, Milwaukee, Wis. The writer was the resident engineer in charge of the work.

In conclusion, the writer is of the opinion that the attitude of the citizens of Carlisle in regard to the construction of the sewer system is illustrative of a condition unfortunately only too prevalent throughout the country. Sewerage in any city of the size of Carlisle is a necessity beyond a reasonable doubt. The demands for it on the grounds of the public health are constantly growing stronger and stronger. Had the citizens of the borough of Carlisle realized the necessity of sewerage at the time when the proposition was first submitted to them every taxpayer would be unquestionably better off. The increase in the prices demanded for labor, materials and other commodities used in the construction of this system was so great during the years that this proposition lay dormant that it has increased the cost of the construction of the system by many thousands of dollars. In addition, the borough has been obliged to bear the expenses of a long drawn out lawsuit which failed to accomplish its purpose.

The experience of Carlisle should serve as a lesson for and be carefully studied by the authorities of those cities in which this matter is now being agitated.

Water-Works Plans of the Public-Utilities Commission of Denver

By A. Lincoln Fellows*

In the year 1910, the people of the city of Denver created a commission called the Public Utilities Commission, whose only powers, however, were to have charge and control of the operation of a water-works, to supply the city and county of Denver and its inhabitants with water for all uses and purposes, and to have control of such other public utilities as might be acquired by the city.†

†See "Eng. News," June 2, 1910, p. 659.

This Commission was specifically directed to offer to The Denver Union Water Co. the sum of $7,000,000 for its plant, and if this were not accepted, to proceed with the construction of a new plant. Naturally, as the valuation of the plant of the Denver Union Water Co., made about a year prior to that time, gave a value of $14,400,000 to the plant, the company refused to accept the offer and brought suit restraining the city from proceeding with the construction of a new plant. This case was finally settled by the United States Supreme Court, which rendered an opinion to the effect that the city had acted entirely within its rights, and that the Public Utilities Commission might proceed with the construction of a new plant, if it desired to do so, in accordance with the terms of the charter amendment, previously mentioned. This decision was handed down in July, 1913, and immediately thereafter the Commission appointed a committee of engineers to make an investigation as to the value of the plant of The Denver Union Water Co., and also make a preliminary estimate as to the cost of a new plant. This committee consisted of the engineering member of the Commission, A. Lincoln Fellows, and of Edmond C. VanDiest, of Colorado Springs, and Charles P. Allen, formerly Chief Engineer of The Denver Union Water Co.

The sum allotted and the time permitted for making the investigations were so limited, that surveys of a new plant were impossible, and only an incomplete report could be made. The committee reported in January, 1914, $10,045,000 as the physical value of the plant, including approximately $375,000 as development expenses. The committee did not place any value upon water rights claimed by the company, taking the position that this was a legal question, which could be determined only by the courts, and no allowance was made for going value other than the development expenses, this being considered also a question to be passed upon by the courts.

The Commission also gave a preliminary estimate of the cost of $12,750,000 for a new plant for the city, this estimate, however, as was stated in the report, being made without surveys, and with only the most incomplete information.

Soon after the completion of that report, at another election held in the city, a plan proposed by some of the business men of the city, which provided for arbitration as to the value of the Denver Union Water Co.'s plant, was rejected by the people by a very large majority. Immediately thereafter the Public Utilities Commission commenced further investigations for the acquisition of certain reservoir sites, and the preparation of plans for a new plant, this being the only course open to the Commission. It has, however, been hampered by another suit, seeking to enjoin the Commission from issuing bonds. The bill was, however, dismissed in the Federal District Court on June 10, 1914, and although an appeal was taken to the Court of Appeals, the Commission is proceeding to advertise the sale of the $8,000,000 of bonds which have been authorized by the people; bids to be opened July 20, 1914. The bonds are to be issued in blocks of $500,000 each, as money may be required.

The Commission plans the commencement of surveys and the preparation of plans as soon as money is available for its work. Certain tentative plans have already been drawn, which will be submitted to a consulting board to be selected at the proper time by the Commission, and the details will then be passed upon by the consulting board.

A number of plans have been presented to the Commission, as follows:

(1) The use of the water of the South Platte River, which is now used as the source of the water-supply for Denver by the Denver Union Water Co.

(2) Tunneling of the Continental Divide by means of a tunnel, approximately 4½ miles in length, and the diversion of the waters of Blue River from the Western to the Eastern Slope. The waters would then be turned

*President, the Public Utilities Commission of Denver; General Manager, the Field, Fellows & Hinderlider Engineering Co., Denver, Colo.

down the South Platte channel to be again taken out in accordance with the laws of the State of Colorado and used for supplying Denver with water.

(3) A similar plan might be adopted with reference to the waters of the Fraser River. An additional complication in this plan is the fact of the voting of $3,000,000 by the city of Denver for the constructin of the so called Moffat Tunnel, which tunnel, while it is to be used for railroad purposes, is nevertheless, in theory at least, primarily for the purpose of bringing water from the western to the eastern slope for the use of the city of Denver.

(4) A similar plan with reference to the waters of Williams Fork, or a combination of Williams Fork and Fraser River.

Whatever course is adopted, large reservoirs must be constructed for the regulation of the supply to be used in the city. Fortunately, good reservoir sites are available and can be had for the purpose when required.

It is the Commission's intention to proceed as rapidly as possible with the preparations of the plans for the construction of a new plant, but as yet no details are ready to be given out. It is hoped that by the first of August parties can be sent into the field for the commencement of this work.

It will be of interest also to note in this connection that the City Council recently passed an ordinance, initiated by the people of the city, for the purpose of reducing the rates of the Denver Union Water Co. 20%. The company has brought suit to restrain the City Council from carrying out the provisions of the ordinance on the usual theory that it is confiscatory. A master has been appointed by Judge R. E. Lewis for the purpose of hearing the testimony, and the hearings are now going on. The company has engaged as its experts in the case Clarence Goldsmith, John R. Freeman, W. L. Holman, George G. Anderson, and Leonard Metcalf. The city will depend for its case largely upon cross-examination and the testimony of local men familiar with various details. The main questions at issue are:

(1) The value of the physical plant.

(2) The value of the water-rights claimed by the company.

(3) Going value.

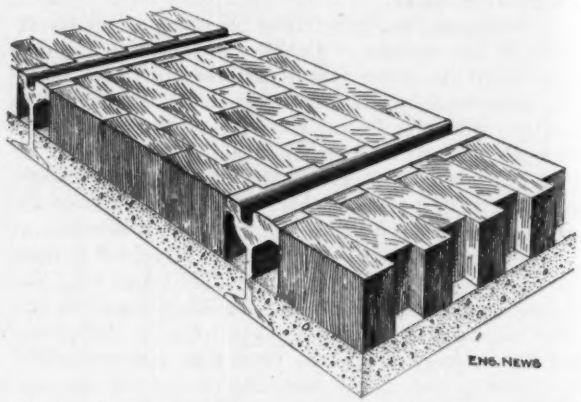
The company claims approximately $11,500,000 for the physical value; $3,500,000 for value of water-rights, and $1,500,000 for going value, a total of $17,000,000.

The city on the other hand contends that there should be included in the physical valuation only those parts of the plant actually useful at the present time in furnishing water to the city; that only such amounts should be paid for water as will compensate the company for the water-rights which it has purchased, and that these amounts should be included in the values given for the lands with water-rights, and that in a rate case, such as this, where there is no franchise and no expectation of granting a franchise, but where, on the other hand, the company is allowed in the streets only by sufferance and until such time as a new plant shall be completed, no going value should be allowed.

In answer to this last contention the company contends that the fact that the construction of a new plant is threatened should entitle it to increased rates because of the obvious obsolescence of the plant to a condition of complete uselessness within a period variously estimated at from five to seven years. At the present writing the master has not definitely ruled regarding this point, but is admitting evidence upon practically all relevant points for later consideration.

A Street-Railway Rail for Block-Paved Streets

The accompanying view shows an indented rail which has been in service for eight years on one of the street railways of Paris, France. The rail was designed to provide a bond between the paving block and the street-car



A Special Rail to Prevent Excessive Wear between Track and Pavement

(From Le Génie Civil, Paris, France.)

rails so that the usual excess wear of the blocks immediately adjacent to the rail might be avoided.

The rail is of the usual tramway type, but is rolled with alternate notches into which the adjacent paving blocks fit. This bond acts to bridge the wearing action of wheels alongside of the rail and the device has been quite successful in retaining an even surface at the edge of the rail. The City Council is so satisfied with its performance in the one place where it has been laid that a much longer stretch is to be placed with a view to further experimentation.

The Fottinger Hydraulic Turbine Transmission for marine propulsion is being developed on a considerable scale in Germany. In the Fottinger system, high-speed steam turbines are directly connected to hydraulic turbines. The water delivered from the latter exerts its power to rotate a low-speed hydraulic turbine mounted on the propeller shaft. While there is in this system a continuous loss due to the friction of the water pasing through the two hydraulic turbines, this is claimed to be more than offset by the ability to use a steam turbine of very high rotative speed and consequent compactness and efficiency and a propeller at the stern of the vessel of low rotative speed and corresponding high efficiency.

One of the vessels on which the system has been applied is the "Kœnigin Luise," a German coasting steamer of 1800 tons. The vessel is equipped with a steam turbine developing 3000 b.hp. at 1800 r.p.m. The low-speed hydraulic turbines which drive the propeller shaft run at 450 r.p.m. A second hydraulic turbine on the propeller shaft has its vanes reversed so that when the water is turned into it the propeller is rotated in the reverse direction. A single valve directs the current of the pressure water delivered from high-speed hydraulic turbine either to the ahead or astern low-speed turbine. The system therefore has the additional advantage of avoiding the use of reversing steam turbines which are a necessity on the ordinary steam-turbine driven vessel. It is stated that the system is to be applied to a transatlantic steamship and also to a German cruiser of 50,000 hp.

Editorials

The Salem Conflagration

The horse has been stolen from the stable at Salem and it does no good now to say that the stable door should have been and might have been locked. Salem's fire department and water-supply were both insufficient; on the other hand it is doubtful whether twice the fire-fighting equipment and a liberal water-supply would have availed to stop the progress of the flames, once well started. The fire hazard of Salem lay in the extensive frame construction in and surrounding high-value districts, and the narrow streets.

The local fire department was augmented by about 60 pieces of fire apparatus and 700 firemen from neighboring cities and towns; but this was too much of a tax on the water-supply, which was further reduced by leakage from broken supply pipes which could not be shut off. A number of buildings were dynamited, in the path of the original fire, but the wind carried burning embers over the waste and the flames advanced without check.

Warnings to Salem were not lacking. As far back as 1907, the National Board of Fire Underwriters made a report on fire risks in Salem. The following significant extracts are taken from the general summary of that report:

Water-Supply and Fire Department—Water supply from sources barely sufficient for present needs. Fire department weak in both apparatus and men.

Building Department—Laws old and poorly arranged. No mention of many fire-protective requirements and devices.

Explosives and Inflammables—Laws inadequate. Inspection not in hands of fire department.

Conflagration Hazard—Severe in and around the principal mercantile districts and the south mercantile and manufacturing district.

Salem has received a fearful blow, but with the energy and pluck characteristic of American cities which have been visited by a similar calamity, is already planning to rise from its ashes. With the erection of new buildings of more modern design and of materials more fire-resistive in the burned-over district the fire hazard of Salem will be less portentous.

Other cities where similar conflagration risks exist might well learn from Salem's disaster. Frame structures cannot, of course, be replaced in a day by steel and concrete and brick; but an inadequate water-supply and weak fire department ought not to be allowed to continue in any city, where such serious conflagration hazards exist.

Engineering Societies and the Public

There are two opposing views as to the functions of an engineering society. One view is that such a society should concern itself solely with the purposes for which such societies were originally organized, which may be defined as the social and professional advantage of its members. The other view holds that engineering societies should improve the opportunities for public leadership which are opening before them at the present time and should become working organizations rather than social clubs.

An excellent illustration of the sort of responsibility which is being laid upon engineering societies where they are willing to assume it is afforded by the laws regarding steam boilers. A half-dozen States have enacted laws fixing standard requirements which makers and users of boilers must observe, and also in some cases establishing examinations for those responsible for the care of steam boilers and their inspection. These legal requirements fixed by different States are so varying and in some instances conflicting that they are a serious burden to steam-boiler manufacturers and purchasers.

It is all very well to say, as many engineers do say, that the States should not pass legislation of this sort interfering with private industry and matters of a technical character. The fact to be faced is that such legislation had been enacted and much more of it is certain to come in the near future. It is said on good authority that the legislatures of some seven or eight states are practically certain to pass a steam-boiler law at the next session.

The American Society of Mechanical Engineers, fortunately, has had a committee at work on this matter for some time and it has already framed a preliminary report and will very likely have a complete report ready for the December meeting of the Society. That report is, we understand, likely to be accepted by the various legislatures as a guide in the framing of laws. Not only this, but other organizations and interests directly affected by such legislation are looking to the Mechanical Engineers to take the lead.

The reason for this is obvious. The public is deeply distrustful of business organizations. If the associated steam-boiler manufacturers should frame a law and offer it for passage by the States, charges would at once be circulated that they had so framed the law as best to protect their interests. The same sort of criticism might be brought against the steel makers, or the boiler-insurance interests. A professional society like the Mechanical Engineers, however, can come before the public and stand a much better chance of having its work accepted as authoritative and unprejudiced.

It may be said that the States should employ and pay engineers as expert advisers to do the technical work of drafting such laws; but suppose the several States did follow this course. What are the chances that the engineers whom a legislative committee might select for work of this sort would be such men as the profession would approve as well qualified to carry it out? Would not the inevitable result be the passage of different laws by different states embodying different and conflicting requirements, making ten times worse the confusion which already exists?

This is but an example of numerous cases where the public demand for legislation effecting Government control of industry can only be satisfied if the expert technical knowledge of the engineer is sought. And it is

vastly easier to shape legislation in the making—to aid in making a law effective and preventing it from being so framed as to work serious injustice—than it is to secure the repeal or amendment of a bad law after it has been placed on the statute book.

It deserves emphasis, too, that the engineering organization is as powerful in this matter, provided it will realize and use its influence, as the individual engineer is helpless. Organization in every branch of trade and industry and professional work are making their influence felt in these matters. The engineer must realize that his own organizations, formed originally for the purpose of mutual benefit and the advancement of the profession, must assume the responsibilities that properly belong to them in working out solutions for the serious social and industrial problems of the present day.

The Neglect of Brick Pavements

In the notable appeal for the substitution of brick pavements in place of bituminous macadam in State highway construction in New York, made by Gov. Glynn some months ago, our readers will remember that he based his chief argument on the small cost of maintenance of brick pavements, placing this maintenance cost at no more than $50 a mile per annum.

From recent inspection of a considerable mileage of brick-paved roads and streets in various parts of the Central West it appears to us that a very considerable percentage of the brick pavements recently laid are suffering deterioration because they apparently have had nothing at all expended on them for maintenance. On many miles of brick-paved roadways in Cuyahoga County, Ohio, which have been laid within a comparatively short time, and are good examples of first-class construction, the only defect noticeable is longitudinal cracks, extending usually along or near the center of the roadway. So long as these cracks remain merely open cracks, they do no injury to the road and apparently nobody pays any attention to them.

What happens, in no very long time, however, is that the calks of horseshoes and steel tires gradually chip away the sides of the crack, and what has been a crack becomes a groove. As soon as the groove becomes wide enough for a steel tire or a horseshoe calk to drop into it, the destructive effect is rapidly accelerated. One sees not a few places on these brick roads where depressions half an inch or more in depth, and six inches to a foot in width, have been hollowed out along the line of what were originally mere cracks in the pavement.

This is, in fact, exactly what would naturally be expected to happen, and what is bound to happen so long as the fallacy obtains that a brick pavement once well laid needs no repairs whatever. It is entirely true, we believe, that such a pavement needs a comparatively small amount expended on it to keep it in good repair, provided it has been originally constructed in a first-class manner; but that small amount it must have, even though it be as little as $50 per mile per year, or damage will be done compared with which the cost of repair would be a mere trifle.

It would be an exceedingly easy matter when these longitudinal cracks form in a brick pavement, to fill them flush with the surface, either with a cement grout of the consistency of cream, or with a mixture of tar and sand in the same way that cracks in concrete roads are mended. From the practical point of view, the tar and sand is probably the best possible material to use. About the only objection that we know of is that it is more or less unsightly and brings the defect to notice just as it does when the same method of repair is applied to a concrete pavement. If cracks in concrete pavements could be filled with cement grout, so that the cracks would not be noticeable, instead of filling them with tar, which advertises the crack to everybody who passes over the road, the reputation of the concrete road would probably be a good deal higher, even, than it is.

City Governments and Electric Lighting Companies

Relations between cities and electric-lighting companies are to be considered at a national conference of city officials next autumn, a call for which has just been issued by Mayor Blankenburg, of Philadelphia, in coöperation with Mayor Mitchel, of New York, Mayor Harrison, of Chicago, Mayor Baker, of Cleveland, and Mayor Shroyer, of Dayton, Ohio.

In the call for this conference, which was sent out last week, it is stated that the city of Philadelphia is soon to appeal to the new Public Service Commission of Pennsylvania, for the adoption of a proper schedule of rates for the sale of electric light and power in Philadelphia. In preparing this case for presentation to the Commission, it has been found that in previous rate cases before Public Service Commissions of other States the side of the public has seldom been adequately represented, while the organization of public-utility companies has in its service the best informed and most able men to be found.

Mayor Blankenburg's letter continues as follows:

> If the cities do not join together for the presentation of their cases, as the public utility companies have done, the laws and precedents established by the Commissions stand in danger of being biased by the able arguments of the representatives of the corporations.
>
> The equipment required for an adequate presentation of the rights and interests of the people involves a degree and extent of technical knowledge and information which it is not practicable for any one city to obtain. It must be borne in mind that the utility companies constitute an offensive and defensive alliance probably stronger than any other interest in this country. Its weakest member is never without information and assistance of every kind. To meet this situation it has been suggested that there should be formed a bureau of public utility research, which shall equip itself to give to the cities the same able assistance which the public-utility companies' association gives to the public-utility companies.

That there is need and opportunity for such an organization as Mayor Blankenburg suggests, would hardly be denied even by the officers of the public-service companies themselves, if they are candid.

So far as water-supply is concerned, there is fortunately no need for such an organization, as the proportion of water-works owned by municipalities is so large that a city desiring to present its side in a rate proceeding or a proceeding to acquire a privately owned works has no difficulty in securing able engineering and legal experts to present its side of the case.

An entirely different situation exists, however, with respect to electric lighting, gas supply and street railways. In this country, practically all the engineers in the gas business are in the employ of private companies and would run serious danger of blacklisting were they to en-

gage as experts on the public side in proceedings to lower gas rates or further municipal ownership of gas plants.

Almost the same situation exists in the distribution of electric current and it is a situation which from the nature of the case cannot permanently continue. It is everywhere recognized by candid and intelligent men, even among the officers of public-utility companies, that the growing public sentiment in favor of municipal ownership can only be counteracted by making public regulation of the utility companies a success. But public regulation can only be a success provided it is guided with the same high-class expert knowledge that is at the disposal of the utility companies themselves.

It is doubtful whether the officers of public-utility companies fully realize the extent to which they have failed to secure the backing of intelligent public opinion in the conduct of their business. We have passed through the stage of competition in the distribution of gas and electricity and the public accepts the fact that the business must be a monopoly; but being a monopoly, the principle of public control must be recognized to the fullest extent. There must be corresponding publicity in relation to corporate affairs. Sooner or later the companies must make public their actual cost sheets of generating and distributing electric current and manufacturing and distributing gas. The public is willing to pay the cost of what it purchases and a fair rate upon invested capital, but it is not willing to be unfairly taxed by reason of monopolistic control or to pay interest on dead capital.

A Searching Criticism of the River and Harbor Appropriation Bill

Senator Burton, of Ohio, is probably the best informed man in Congress on the government's work for the improvement of rivers and harbors. He served for many years while in the House as chairman of the Rivers and Harbors Committee. He was also chairman of the National Waterways Commission of 1909-10, which reviewed the whole subject of government expenditure for the improvement of navigation and laid down the policy which the government should follow to meet economic conditions of the present day.

Notwithstanding the publicity which was given to the report of that Commission and the general discussion which has taken place on the subject, river and harbor bills continue to be framed in the same old way. It is therefore refreshing to find a man of Senator Burton's ability and experience coming forward with a public criticism of the present pending river and harbor bill, which deserves to attract public attention.* Certainly it should receive the attention of engineers, for the subjects therein discussed are subjects on which the expert technical knowledge of the engineer is essential to sound reasoning.

And at the outset it may be well to lay down what is the point of view from which river and harbor appropriations should be considered. As a matter of fact, the strong influences at work for river and harbor appropriations are first of all the local interest which judges the efficiency of a Congressman by the extent to which he can draw upon the Federal treasury for funds to be spent within his district. Second comes the interest of those who wish appropriations made for rivers and harbors, ostensibly to improve navigation, but really for the benefit of lands subject to overflow, erosion, etc. In the third place come the interests which seek large river and harbor appropriation bills because of the opportunities for profitable contracts that may result. Finally comes the comparatively small minority which seeks Federal appropriations for the benefit of water transportation.

There can be no dissent, however, from the proposition that the last consideration is the only one that can in any way justify the use of the nation's funds, collected from the taxpayers, upon waterways for interstate commerce. Not a few of the Congressmen who join in the scramble to secure their proper share of the distribution from the river and harbor pork barrel frankly deplore the necessity which compels them to join in a riotous waste of the public funds for which no corresponding benefit is received.

The river and harbor appropriation bill, as reported by the House, carried total appropriations of $43,400,000, which have been increased by the Senate to $53,680,000. Of this amount about $10,350,000 is for beginning work on projects which are to be completed under the "continuing contract" system. This means that small sums have been appropriated to start works on projects for which much larger amounts must be appropriated in following years, or the entire work will be a total loss.

In the present year the amount necessary to be appropriated in the sundry civil appropriation bill on continuing contracts will be between seven and eight million dollars. On this basis, therefore, the entire amount to be spent by the government on river and harbor improvements during the fiscal year under the pending appropriation bill as reported in the Senate will be in round numbers $60,000,000.

Senator Burton, however, rightly says that it is not the amount of the appropriation, large though it is, but the methods by which the appropriations are made that most deserves public criticism. He declares that many of the appropriations are made for waterways which under present conditions cannot be profitably improved. And, further, that the bill contains large appropriations for local benefits which have little to do with navigation.

As our readers know, the idea has been spread abroad by energetic workers for river and harbor appropriations that the United States has neglected its water courses, and that this is the reason why the traffic upon them has declined and in many cases entirely disappeared. On this subject, certainly, Senator Burton, by reason of his long service on the Rivers and Harbors Committee of Congress, can speak with high authority. We quote from his report as follows:

> **An erroneous impression prevails that the government of the United States has not been liberal in its appropriations for the improvement of rivers and inland waterways. This is altogether incorrect. More money has been expended for these purposes by this country than by any other of equal population or equal area.**

As is well known, commerce on the Mississippi River has dwindled away until its commercial importance is today trifling. In 1880, the volume of traffic on the Mississippi River between St. Louis and Cairo was reported as 1,030,000 tons, and with a ruling depth of water of only 3½ to 4 ft. Since that time the government has

*Senator Burton has submitted a minority report on the River and Harbor appropriation bill, printed as Senate Doc. 522, 63d Congress, second session, Report 599, Part 2.

expended $15,574,000 to provide an 8-ft. depth of water over this section of the river, and such a channel has been available to traffic for years. The traffic on the river, however, has steadily decreased and was only 265,000 tons in 1912.

The money which Congress has appropriated to improve these 206 miles of the Mississippi River in the last 25 yr. has far exceeded the amount spent by Germany in the improvement of the River Rhine from the frontier of Holland to Strassburg, a distance of 355 miles. Yet this section of the Mississippi had only 265,000 tons of traffic in 1912, while the commerce on the Rhine was nearly 40,000,000 tons, or about 150 times as great. In addition to the amount above noted, there has been spent by the government on the lower Mississippi between Cairo and the head of the Passes since 1879 the sum of $78,409,000, notwithstanding which fact the traffic shows a steady decrease. It fell off one-half in the decade from 1901 to 1910.

It may be remarked in this connection that it is not always safe to take mere tonnage figures as a basis on which to estimate the importance of commerce on an inland stream. An analysis of the commercial statistics shows that in many cases the tonnage of traffic which is reported consists largely of sand, gravel and stone. In 1910, more than a third of the Mississippi River commerce between Vicksburg and New Orleans consisted of these low-grade materials.

It should not be understood that Senator Burton in his report stands opposed to all appropriations for river and harbor improvement. On the contrary, he approves of the expenditure of public money upon those projects which can be shown to justify the expenditure upon them by the traffic which they bear. Many so called rivers included in the river and harbor appropriation bill are really arms of the sea. The money expended upon them to enable ocean vessels, larger or smaller in size, to navigate them and use them as harbors shows often very large returns in the way of benefits to commerce.

There is a general popular impression that the United States has been derelict in the improvement of its seaports. Regarding this, Senator Burton says:

> The United States has first-class harbors not only in much greater number than any other country of the world, but the distance between them is generally not so great as in the very thickly populated countries of Europe. The Republic of France has but four or five first-class harbors, and Germany has but three. The harbors of the United States already improved, or on which improvements are well underway, surpass those of any other country.

It is with respect to the improvement of inland waterways that Senator Burton's chief criticism is directed. Prior to the advent of the railway as a freight carrier, the navigable rivers of the country rendered an important service in carrying long-distance traffic. Analysis of the present water-borne traffic proves that long-distance inland transportation by water has almost wholly disappeared. Where the rivers are still being used for freight, it is almost wholly local.

Turning now to the record of actual results from the Government expenditures on inland waterways, Senator Burton instances the Red River below Fulton, Ark. For a distance of 475 miles on this river there was in 1912 a total traffic of 44,967 tons, of which 42,640 tons were saw logs. The United States has spent on the improvement of this stream $2,768,000, and the pending river and harbor bill proposes to add $100,000 to this sum. Senator Burton computes that, figuring interest at 4%, the cost to the Government for every ton of traffic carried on this stream last year would be $4.68. With the saw logs excluded (since they have been floated on the river without any improvement) the cost per ton, to the Government would be $90.56, and the cost per ton-mile, $1.53. The Red River, moreover, is not an isolated example of the waste of river and harbor appropriations by any means. The United States has spent on the Arkansas River $3,108,000, and the pending bill proposes to add $164,000 more, yet the river carries a total traffic of only 71,516 tons in a year, of which 56,000 tons were saw logs. Going to the far West, on the Columbia River about Portland, the United States has spent about $9,000,000, and the total traffic on this stretch of the river is now only about 80,000 tons per annum.

There has been great agitation, in recent years, as many of our readers will recall, to secure the improvement of the Missouri River. Great things were promised by certain commercial associations as to a revival of boat traffic upon that stream, and the agitators were successful some years ago in inducing Congress to resume appropriations for its improvement.

Before the advent of the railway the Missouri was, indeed, an important avenue of traffic for the pioneers, but steamboat traffic on it disappeared years ago and in 1902 Congress decided that it was not worth while to expend further money on the stream. At that time the appropriations for it had amounted to $7,227,000. As a result of the agitation above referred to, the Government is now committed to a project to spend $20,000,000 more on the river between Kansas City and its mouth, of which $4,400,000 have already been appropriated. The traffic on the river in 1912 was 185,110 tons, of which sand and gravel hauled one mile made up 155,420 tons, leaving 29,690 tons for all other freight. The bulk of even this, however, was local traffic and the only long-distance traffic to be found in the record is 4173 tons of miscellaneous freight carried 339 mi., and 1404 tons of manufactured iron and steel products, carried 158 mi.

Senator Burton, however, suggests the real reason behind the agitation for the Missouri River improvement. From an official report filed in 1908 it appears that lands adjacent to the river, amounting to over half a million acres, would be benefited by the proposed improvement. Naturally the owners of this land desired to have it protected from erosion or overflow at the expense of the Federal Government!

The most signal instance of waste of public funds in river and harbor appropriations, however, is in connection with the improvement of rivers by slack water navigation. "It may be confidently asserted," says Senator Burton, "that the only waterways in the United States which can be profitably improved by the construction of locks and dams are the Monongahela, the Kanawha and the Ohio, which are improved by the Federal Government, and the Barge Canal connecting Lake Erie and the Hudson River, improved by the State of New York. It is possible also that the improvement of the Alleghany and the Black Warrior River in Alabama will prove desirable."

We should say that it is an open question whether the traffic on even these streams will in the end justify the expenditure which has been made upon their improve-

ment. Certainly at the present time, with the sole exception of the Monongahela, there has been no evidence of such a result.

As examples of waste of public funds in slack-water navigation, Senator Burton cites among others the famous Hennepin Canal, which connects the Illinois and Mississippi Rivers. Its advocates thirty years ago maintained that its construction would save the public $20,000,000 per annum in freight. Its construction dragged along over many years with the piecemeal appropriations which Senator Burton roundly condemns, and it was finally opened for traffic in 1908. Up to date the Government expenditures upon it have been in round numbers $8,740,000, and it carried last year only 11,962 tons of commercial freight. In the year 1909 the tonnage of material hauled for repairs and improvement of the canal itself was more than 22 times as great as the commercial freight handled over the canal.

Muscle Shoals Canal, on the Tennessee River, has cost the Government four and one-half million dollars and in 1912 the freight passing through the canal amounted to 5520 tons.

On the Big Sandy River, located on the boundary between Kentucky and West Virginia, the Government has expended about $2,000,000 in constructing locks and dams, and the total tonnage carried in 1912 was 500 tons. During this same period the railway operating in the Big Sandy valley handled 2,225,000 tons of freight.

These are extreme, but not isolated, examples of the practically total failure of the Government's expenditures in slack-water navigation projects to produce any benefit to commerce at all proportionate to the cost. Yet in the face of these well known facts, government appropriations for building locks and dams still continue. There might be the shadow of an excuse for them where such structures are built to complete a project already begun; but what possible excuse can there be for the Government to undertake new projects for improving inland rivers by a system of transportation which has been proved obsolete? The present river and harbor bill, however, contains appropriations to begin the construction of a complete system of locks and dams on the Brazos and Trinity rivers in Texas. Senator Burton sets the cost of the entire project at $10,000,000 for each of these rivers, and there is reason to believe that much larger sums would be required before the useless work could be carried to final completion.

Much more could be said to prove that of the sixty million dollars a year which the Government spends for navigation improvement, a large part is spent on works which afford no corresponding benefit to commerce; but the facts are already well known to many engineers. That the remedy for this wholesale waste does not lie in change of political parties is seen by the fact that the Democratic majority responsible for the present River and Harbor bill has pursued the same methods and gone merely a little farther than its Republican predecessors. It is seen also in the fact that some of the Progressive party leaders have been leaders also in the popular agitation in favor of waterway improvements.

How strongly the beneficiaries of the present River and Harbor system are intrenched is proved by the fact that with all the exposures of its iniquities by such men as Senator Burton and President Taft, and many years ago by President Cleveland, to say nothing of many others of prominence, the system still continues to draw money from the national treasury in a flood which increases year by year.

Sometime, perhaps some influential commercial or technical organization may be able to bring about a reform. Until that happens the nation will continue to calmly pour out millions a year into pools and ditches to perpetuate obsolete systems of transportation and benefit a traffic which has disappeared.

Letters to the Editor

Band vs. Spiral Hooping for Concrete Piles

Sir—Referring to the note on "Strength of Band and Spiral Hooping," in reinforced-concrete piles, in your issue of May 28, 1914, p. 1202, it seems possible that a more comparative test of the spiral and band reinforcing would have resulted from two test piles being driven under identical conditions, one reinforced spirally and the other reinforced with bands.

The effect of the band reinforcement probably was such that the two systems, being in conjunction, influenced detrimentally the weaker system. Although a great many experiments have been made to determine, if possible, the best method of pile and column reinforcement, no agreement has apparently been arrived at between the various authorities.

From his experience with reinforced-concrete piles the writer is inclined to think that the weakness of the spiral system lies in the fact that a rupture at any point must necessarily affect detrimentally the spiral binding for a considerable distance on either side of the break—this effect diminishing as the ratio of the distance from point of rupture. The whole of that portion of the pile contiguous to the rupture being no stronger in its resistance to crushing stress than if the pile were reinforced with longitudinal bars only. In other words, spiral reinforcement depends almost entirely for its effectiveness upon its continuity, whereas band reinforcement, being made up of a series of units, does not allow the compressive strength of the pile to be affected except locally by the breaking of a band.

Tests have shown that while spiral or band reinforcement increases the crushing strength of the column, the shortening due to deformation is very great at a comparatively early period of the load application—so much so that it would seem hardly good practice to base the safe strength directly on the breaking strength. This early deformation appears to be about equal to the maximum for plain concrete. Upon the increase of the load the

failure of the concrete is prevented by the hooped reinforcement, but the concrete continues to expand laterally, thus the elasticity of reinforced-concrete piles depends upon the strength and elasticity of the hooped reinforcement. It has been found that hooped reinforcement —while giving the necessary elasticity to columns or piles, and postponing failure beyond the time when the concrete shell outside the reinforcement has failed by cracking and peeling—does not increase the stiffness under comparatively low loads.

F. H. FRANKLAND,
Bridge Engineer, Highway Dept., Calcasieu Parish.
Lake Charles, La., June 5, 1914.

Floods in Texas Since December, 1913

Sir—Since the disastrous floods of December, 1913 (described at length in my article in ENGINEERING NEWS, May 21, p. 1116), Texas has suffered another, but less severe loss by a series of heavy rains which began on Apr. 21 and continued at close intervals until June 1. The rainfall for May, 1914, averaged 7.68 in., which is 0.61 in. more than the average for June, 1899, which heretofore was the wettest month of record. Until the latter part of April the weather was about right for the farmer and prospects for bumper crops were excellent. A temporary let-up of precipitation occurred during the week ending May 11, which was promising at the time, but did not appear to help much. Heavy rains set in again on May 12 and after that date farm work came to a standstill.

The soil was too wet for cultivation and roads for the most part were impassable. In some parts land was badly washed, resulting in much loss of crops; in others, weeds and grass made rank growth and injured the crops, especially corn and cotton, and a large acreage will have to be replanted. Railways suffered from washouts and softened roadbeds.

All streams from the Rio Grande to the Sabine were more or less flooded, but the runoff was smaller than the amount of precipitation would indicate, and it is probable that the rank growth of weeds and grass prevented or at least retarded drainage into the main channels. There were strong fluctuations in the streams and at some stations flood stages were attained several times during the month. The stages were generally well below high-water mark, but there was much apprehension among the farmers of the lowlands.

The damage from the water so far reported aggregates $1,750,000, but is likely to be much greater, as the returns are far from complete. Of this amount $465,000 was reported from the Trinity; $299,999 from the Brazos; $733,000 from the Colorado; and $126,000 from the Guadalupe Valley; and the remaining $127,000 from other watersheds and from a small per cent. of railway and telephone companies. There were 11 deaths by drowning in the swollen streams. Savings effected from warnings, so far as reported, amount to $124,000. Loss of live stock was small.

While pessimistic reports were received from many sections of the state during the rainy period, the outlook in the Panhandle and West Texas is promising. Ranges were reported never better; cattle fattening, and small grains in good condition; and now, that favorable weather has set in, the soil cultivated and much cotton and corn replanted, hopeful reports are coming in from nearly all sections.

So far as known the levees which were injured or destroyed by the December floods have not been rebuilt; but the matter is being agitated in the press, and the Reclamation Department of the state is receiving applications to furnish surveys and hydraulic information. Arthur A. Stiles, State Reclamation Engineer, in a letter to this office stated his belief that the tendency will be to give more careful attention to engineering details in rebuilding these levees than seems to have been exercised when they were first built.

B. BUNNENEYER,
Section Director.
Local Office of U. S. Weather Bureau.
Houston, Tex., June 25, 1914.

A Mexican Engineer on International Relations

Sir—Owing to the irregular postal service, due to the situation prevailing in this country, it is only lately that I received ENGINEERING NEWS of Apr. 30. The interest which I always find in the editorials was considerably increased when I found that the title of one of them was "War with Mexico."

For many years I have constantly read ENGINEERING NEWS, as I consider it to be the first engineering publication in the United States and, most certainly, one of the best in the world. For this reason I esteem it as a safe guide in professional matters, as well as one of those old friends which we love because we know they are good. I fancy that I am intimately acquainted with its editors, although I have never seen them, and although they belong to another race, talk a different language, profess a different religion, have different habits, are inspired, perhaps, by different ideals and their hearts beat under different sentiments. At the same time, they are in communion with myself because of our common high regard for the engineering profession, and because of their strict proceedings and the nobility of their aims. We are all members of the great human family, and honest men of every nationality must stand together in defense of righteousness and truth. For all of these reasons I venture to write you to tell you the impressions made on my mind by that editorial entitled "War with Mexico."

I did not find—nor did I expect to find—a single word of sympathy for this people which struggles in such anguish for the solution of their tremendous political and social problems, nor did I find a single reproach to the American Government for its aggressive action toward a weakened people, action taken contrary to the promises of President Wilson before his arrival in power, which promises announced to the Latin-Americans the initiation of an era when the jingo would be suppressed and politics would be made subordinate to morals. But I certainly see in the editorial "War with Mexico" the same intelligent viewpoint which has always inspired the editors of "ENGINEERING NEWS;" the same sound logic in their arguments, the fair and judicial spirit which rules their discussion, and above all, the touch of honesty which characterizes the conduct of this journal.

I have always believed that the American engineers, considered as a body, represent the highest principles of probity and justice. George Washington and Abraham Lincoln devoted some of their activity to the noble profession of engineering. I have been personally acquainted with many engineers who are your fellow countrymen and I hold in high esteem their talents as engineers and their qualities as men. Some of the men who stand in the first rank of American engineers have lived in Mexico at some time and undoubtedly their hearts beat in sympathy with this hospitable land which tendered them every kind of favors and courtesies: A. M. Wellington, Captain Jas. B. Eads, E. L. Corthell, Howard and James Schuyler.

The high opinion I always held of the Yankee engineer has been strengthened by the wonderful address of Prof. George Fillmore Swain, Past-President of the Am. Soc. C. E., which was read at the 45th Annual Convention of the Society, held in Ottawa, Ontario, in the month of June, 1913. When a corporation has such eminent members as Prof. Swain, we can be sure it will always go forward in the right track.

As a general rule, the engineer (the genuine engineer, not the man who empirically carries on the profession), due to his knowledge of exact sciences, physical and natural, as well as to his intimate touch with nature, loves truth and justice and right, and hates deceit and hypocrisy. For this reason such a man everywhere stands above the common level. If in the United States, at some happy day in the future, engineers should rule over the political life of the nation, the Latin-American peoples could rest in tranquility. Such men would surely disclaim the infamous maxim of Bismarck: "Reason and Right stand on Strength." They would direct their activities through different channels as they would understand that justice and respect for another's rights are the firm foundation for the moral greatness of nations, the only one that can last through centuries.

Turning to another subject: Whenever, in any country, foreigners live and prosper during peaceful and orderly times and enjoy every kind of security for their honest industry they are bound to suffer the consequences of disturbances in connection with any struggle for the solution of the problems connected with the internal life of the nation and the settlement of the basis of civilization. According to the sound principles of international right and justice, a powerful government must not interfere with the internal differences of another country, nor even exact from it any claims for his citizens who have suffered damage, and this will assuredly happen when moral law rules in the world.

You know well how General Sherman's army devastated the country in his triumphal march throughout the Southern states, at the time of your Civil War. You know also that the Federal Government did not pay any claims on account of this damage either to Americans or to foreigners. When England exhibited its claims, the answer was the most round refusal.

At the moment I write these lines I do not know the result of the Niagara Falls Conference, but be it what it may, and whatever the destiny reserved to this country, weakened and impoverished by nearly four years of civil war, and held by an extraneous hand which hinders the solution of its difficult social problems, I will always keep in good remembrance the honesty and fairness of ENGINEERING NEWS, in reference to the possibility of a war with Mexico, virtues in harmony with the irreproachable conduct of that journal which has won its great reputation.

L. PEREZ CASTRO,
M. Am. Soc. C. E.

Box 1354, City of Mexico,
June 4, 1914.

Unit-Stresses for Steel Highway Bridges

Sir—Recently, while designing several highway bridges, the writer noticed that different specifications give widely varying results, although all are supposed to give a bridge of the same capacity.

One of the bridges has a span of 250 ft., 20-ft. clear roadway, brick pavement on a reinforced-concrete slab. The stresses in the bottom chord at the center of the span are dead-load 411,700 lb., live-load 153,000 lb. The net section required, etc., according to several specifications is shown by the accompanying table.

TABLE OF UNIT STRESSES FOR STEEL HIGHWAY BRIDGES

Specification	Tension Unit-stress live load	Tension Unit-stress dead load	Unit shearing stress shop rivets	Net area required	Number ¾-in. shop rivets required in single shear	Impact
Cooper's Highway '09	12,500	25,000	10,000	28.7	94	No impact
Ketchum	16,000	16,000	12,000	37.9	84	*I = $\frac{8\times150}{L+300}$
American Br. Co.	17,000	17,000	12,000	35.5	84	25% live-load
Osborn Eng'g Co.	22,000	22,000	10,000	27.6	101	*I = $\frac{8\times8}{8+D}$
C. C. Schneider	16,000	16,000	12,000	37.9	84	*I = $\frac{8\times15}{L+300}$

*I = impact stress. S = liveload stress. D = deadload stress.
L = loaded length, ft.

It seems to the writer that this wide discrepancy should be eliminated and standard unit-stresses adopted. It also seems reasonable that where the dead-load is large in proportion to the live-load a higher unit-stress might safely be used than where the dead-load is comparatively small.

It would also seem reasonable to make little or no allowance for impact where you have a concrete-slab floor.

E. P. KNOLLMAN.

Columbus, Ohio, June 20, 1914.

A Highway Water Supply—A very unique feature relative to the Manila-North Road, unique when the highways of the world are considered, but not unique in the Philippine Islands, is the copious supply of excellent artesian water flowing at its side. The traveler will not find it necessary to trouble the housewife for a drink of water, nor the cantina nor the hotel, neither will he find it necessary to trespass upon private property to reach water. The Bureau of Public Works has drilled hundreds of these wells, and several of the provinces have purchased well-drilling machines in order to extend the well system more rapidly. Nearly every town has several of these wells and generally one may be observed at the roadside every few minutes as the traveler passes along. The water is pathogenically pure, clear, sparkling, cool and flowing, which conditions are a natural sequence after the waters have fallen upon the distant and forest-covered sierra, and have percolated for miles through the porous stratum to the perforation made by the bit of the well-drilling machine. Thus, it may be observed that ample facilities to obtain potable water exist for man and animal, and for motor cooling. Previously, it was stated that the artesian wells were not unique relative to this main trunk line. They are also being drilled by the side of the second- and third-class roads, not only in the plains region of central Luzon, but throughout the archipelago.—"Quarterly Bulletin," Bureau of Public Works, Philippine Islands, Apr. 1, 1914.

Timbering in Open Cut for Fourth Ave. Subway, Brooklyn

The collapse of the timbering in the excavation for the new Fourth Ave. subway between 76th and 77th Sts., Brooklyn, N. Y., at about 9 a.m., on June 23, dropped a 10-ton stiffleg derrick mounted with hoisting engine on an 8-wheeled truck to the bottom 30 ft. below. When completed, this section of the subway will be the 76th St. station; hence the cut is about 17 ft. wider than between stations. At this point the width is about 55 ft. and the depth to subgrade 30 ft.

The soil is mixed sand and clay and quite firm. The 2-in. timber sheet piling (not tongued and grooved) which retains it, is braced every 10 ft. by a bent built of four tiers of transverse braces, which extends entirely across the cut, butting against the wales of the sheet piling on each side. Between the several tiers at irregular intervals wood posts are set. Further stiffening against buckling is provided by two lines of 3x8-in. longitudinal bracing. The transverse braces and posts are, for the most part, 10x10-in. Fig. 4 shows the method of bracing the sheet piling.

A traveling derrick, located approximately as shown in Fig. 1, was working ahead, removing with a 1-cu.yd. dump bucket the lower 15 ft. of earth. The traveler was built of four longitudinal 12x12-in. stringers, mounted on 8 steel wheels, four per side, on a track of about 20-ft. gage. A number of wood beams placed at right angles to the stringers carried the flooring, upon which was mounted the derrick (in front) and a shanty containing the hoisting engine. The derrick had a 40-ft. boom.

Figs. 2 and 3 show conditions subsequent to the collapse. The mass of wreckage gives little indication as to the direct cause of the failure. Just prior to the acci-

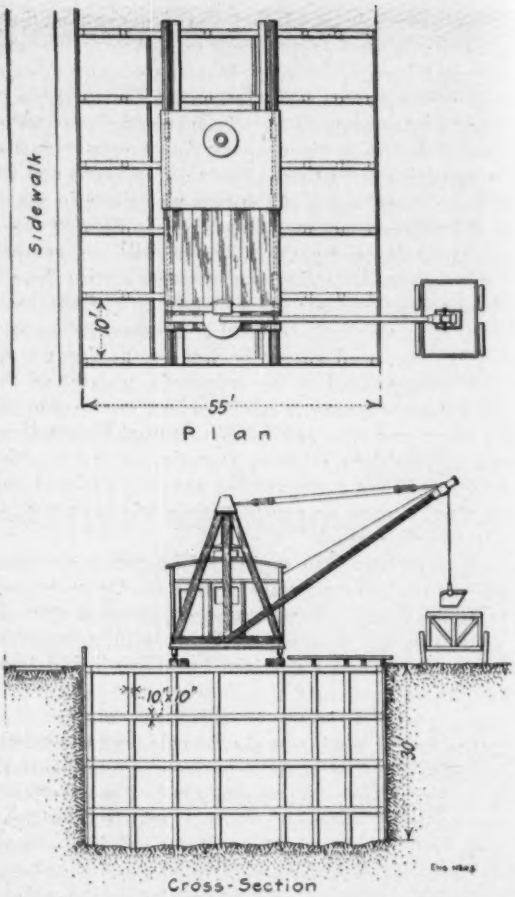


FIG. 1. GENERAL SCHEME OF TIMBERING AND POSITION OF TRAVELER AT 76TH ST.

FIG. 2. VIEW OF THE BREAK FROM THE WEST

(Cross-bracing at left; three lengths of unsupported water main in front of caved earth; truck and derrick in the cut.)

FIG. 3. THE WRECKED DERRICK AND THE TIMBERING AT UPPER FACE OF BREAK

FIG. 4. GENERAL METHOD OF BRACING SHEET PILING IN 15-FT. CUT

dent the traveler had been moved forward about 20 ft. and was again operating. Three bents, together with the sheet piling on one side, collapsed. The fourth bent on the upper side of the break sagged, and several of the posts were displaced, as shown in Fig. 3.

It is possible that earth pressure caused one of the braces to knuckle, as the longitudinal bracing was flimsy. On the other hand, the timbering carried a live load in the form of a derrick; it is, therefore, possible that one of the bottom posts supporting the lowest brace in one of the bents collapsed, due to undermining, either from the digging operations or from ground water. There is no information that a moving bucket struck the timbering nor that the derrick itself failed.

At the time, 20 men were working down in the cut (12 muckers and a timbering gang of 8 men). One man was killed, another died a few days later, and five others were injured. A team and truck fell into the cut, killing one of the horses. Three 10-ft. lengths of a 16-in. water main were left entirely without support (Figs. 2 and 3); but the main did not break. The water, however, was ordered cut off, and there was no pressure from 9 a.m., until 5 p.m. In the meantime the main was stiffened by suspending from a steel I-beam.

SINCE THE COLLAPSE

A jinney-winch, to be caused by the steel erectors, was fortunately at hand and was pressed into service. It was installed just back of the collapsed portion of the timbering, and proceeded to retimber the break, working forward. On June 26, this work was nearly completed. To continue the mucking a new traveler has been erected of the same design as the old, but on the opposite side of the break. This was done so as not to interfere with the operations of the jinney-winch.

The new traveler was placed in service June 30. It moved backward on the timbering of the first cut, which is only 15 ft. deep. The transverse bracing here is of the same character as in the deeper cut, but there are only two cross braces per bent instead of four. The spacing between bents is still 10 ft.

This method of moving the traveler is not so satisfactory as was the old, where it moved on the final timbering; but the total duration of the work will be shorter than would be the case with the jinney-winch taken out of service and moved to the opposite side of the break. The new traveler could not be erected back of the winch,

because of the interference of a temporary highway bridge.

Method of Excavating at 76th St.

The first cut, of 12 to 18 ft., was made with a steam shovel traveling on the ground. It was the original intention to make the second and final cut with a locomotive crane traveling on the bottom of the first cut. Failure to deliver the steelwork for the subway caused this plan to be abandoned; the locomotive crane merely removed

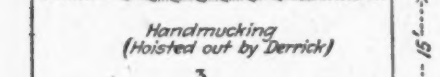


Fig. 5. Method of Excavating at 76th St.

(The first cut was made with a steam shovel; side slopes removed by a locomotive crane traveling at 15-ft. sublevel. The next cut will be mucked by hand and earth removed by a derrick traveling on top of timbering.)

the side slopes left by the shovel. The cut was then timbered, and work transferred to other portions of the line. Had the work proceeded without interruption at this point, this section might have been completed several months earlier.

When it was decided to reopen operations here, the presence of the timbering made the employment of the locomotive crane impracticable. A traveling derrick was, therefore, erected on the timbering, and the work proceeded until the unfortunate accident described. The mucking was done by hand and the material hoisted by the derrick. Three buckets in rotation were employed. About 300 ft. of mucking remains to be done here. The derrick had been in use several weeks on this class of work.

The Degnon Contracting Co., New York City, was general contractor on this section. The subcontractor was Carpenter, Boxley & Herrick, Inc., Roanoke, Va.

Annual Convention of the American Railway Master Mechanics' Association

The 47th annual meeting of this association was held at Atlantic City, N. J., June 15 to 17. Below is a brief account of the proceedings supplementing that given in the "Society Proceedings" column of last week's issue.

Mechanical Stokers for Locomotives—This subject is of growing importance with the increase in train loads and power of locomotives, and the committee's report showed that the mechanical stoker is no longer an experimental machine. At the present time there are about 500 Street stokers (82 being built), 300 Crawford stokers, and a few of half-a-dozen other designs. The average mileage per machine failure (exclusive of failures due to improper handling) has been about 53,400 miles on the Norfolk & Western R.R. and 44,300 miles on the Baltimore & Ohio R.R.

The mechanical stoker is not to be considered primarily as a coal-saving device, but rather as a power-increasing device, and the general experience is that the stoker engines can haul heavier loads than hand-fired engines. Further, the stoker can work to full efficiency throughout the run, while a fireman's efficiency falls off as he becomes tired. But the stoker needs to be handled carefully to maintain the full efficiency and power of the engine and to avoid excessive coal consumption. The discussion strongly indorsed the position taken by the committee.

Superheater Locomotives—The report dealt with the results of various changes in the form and dimensions of superheaters (Schmidt type) on the same engine, as shown by experiments on the locomotive-testing plant of the Pennsylvania R.R. It dealt also with the question of piston packing and rod packing that will resist the action of superheated steam. A paper by H. W. Coddington (independent of the report) described road tests on the Norfolk & Western R.R. with engines having Schmidt superheaters, but with and without firebrick arches. The former showed a saving of 5% in coal consumption.

Fuel Economy—This report constituted a digest of replies to a list of questions. It advocated the purchase of coal by specification, the keeping of accurate coal-supply records, the use of good feed water (with treatment if necessary), the reduction of waste due to coal falling from tenders and cars, the keeping of engines in proper condition, and a full coöperation between enginemen and firemen and between these men and their superior offices. It suggested also that the use of pulverized coal may effect considerable economy.

In regard to good feed-water, the report stated that the saving due to reduction in scale and decreased boiler maintenance will pay for the cost of treating the water. The discussion tended to show that while scale is undesirable it has practically no effect upon fuel consumption. As to the selection of good coal, another view presented was that it is better to provide for the effective use of the poorer grades of coal.

Smoke Prevention—Steam jets and blowers are used by a number of roads, and the former are considered to be very effective. One road uses a perforated ring blower around the top of the stack. The mechanical stoker and the brick arch tend to reduce smoke, but the effect of the superheater in this respect is varied. Only one road has introduced apparatus for dealing with the smoke at roundhouses, and this coal-washing plant (on the L. S. & M. S. Ry., at Chicago) was described in Engineering News, May 15, 1913. The various devices used on the engines are efficient, but the men must be trained as to their proper use. The subject is of importance since so many municipalities are taking up the question of abating the smoke nuisance.

Train Resistance and Tonnage Rating—The committee recommended certain car-resistance diagrams and tables for use in computing the tonnage rating (a) for track having heavy rails and a high degree of maintenance, and (b) for lighter track with medium maintenance. The figures recommended in the report were objected to as being based on insufficient investigation, and the report was referred back to the committee for further consideration.

Special Alloys and Heat-Treated Steel—The committee stated its opinion that the manufacture of plain carbon and alloy steel to be quenched and tempered will eventually be developed to the point where such material can be used in designs involving much higher unit working stresses than are possible with untreated or an-

vealed plain carbon steel, with a consequent reduction in the weight of parts.

LOCOMOTIVE HEADLIGHTS—A voluminous report described a number of road and laboratory tests, and gave the rules of various railways and the requirements of various public authorities. The conclusions were as follows: (1) the headlight must have a beam candlepower not greater than 3000 cp. at 500 to 1000 ft. from the engine, in order to avoid such intensity as would interfere with signals (block, hand, etc.), and temporarily blind an engineman looking into it; (2) the headlight should have an apparent beam candlepower of not less than 450 to 500 cp. at 500 to 1000 ft. from the engine (and 30 to 350 cp. at distances of 50 to 400 ft. from the center line), in order to give sufficient illumination to show landmarks, crossing and other signs, and to enable the engineman to readily perform his duties at terminals, etc.

The discussion brought out the disadvantages and incidental dangers of high-power headlights. It was suggested that one reason why enginemen have advocated such lights is that they give a better side illumination, enabling signs, etc., along the right-of-way to be seen readily. This side illumination or lateral spread of the light is of more importance than a powerful beam of light directed straight ahead.

OTHER REPORTS AND PAPERS—Other committee reports were as follows: (1) Rules for road and laboratory tests of locomotives; (2) Revision of standards and recommended practice; (3) standardization of tinware (oil cans, buckets, etc.); (4) train brake and signal instructions. The committees on boilers and safety appliances made no reports. There were also other papers as follows: "Flange and Screw Couplings for Injectors," by O. M. Foster (L. S. & M. S. Ry.); "Electric Motors in Railway Shops," by B. F. Kuhn (L. S. & M. S Ry.), and "The Minor Mechanical Organizations," by Angus Sinclair.

Annual Meeting of the Master Car Builders' Association

The 48th annual meeting of this association was held at Atlantic City, N. J., June 10 to 12.

In his presidential address, M. K. Barnum (B. & O. R.R.) referred to the necessity of equipping freight cars promptly with the safety appliances called for under the present laws. The building of wood passenger cars has practically ceased, and many roads are applying steel underframes and steel ends to the existing cars, while much work has been done in improving the older freight cars by applying steel underframes and ends and heavier draft gear. He advocated standard dimensions for 40-ft. and 50-ft. freight cars, but pointed out that when the American Railway Association some years ago adopted a standard 36-ft. box-car the traffic departments at once began to demand special sizes. At the present time very few of these "standard" cars are built.

CAR CONSTRUCTION—The principal feature of interest in this report was its recommendation of a minimum cross-sectional area of 24 sq.in. for the steel center sills of new cars. H. H. Vaughan (Can. Pac. Ry.) opposed this as being too high, he having had satisfactory results in four years' service with a number of cars having only 20 in. of metal. Others thought four years too short a time, and reference was made to cars having 35 to 40 sq.in. in the sills. The matter will go to letter ballot.

The question of standard design of box-cars also produced decidedly opposite views, some considering that car design is at present in a state of evolution, and that standardizing would be premature, while others thought it time to take the matter up, especially as it would be some years before any standard design could be submitted and adopted. The statement was made that the American Railway Association has been making an investigation as to interior dimensions of box-cars, with a view to adopting some standard, and will submit the matter to the Master Car Builders' Association.

RETIREMENT OF 20- AND 25-TON CARS—This committee recommended that cars of less than 30-ton capacity should not be accepted in interchange service after Oct. 1, 1916, and this will be submitted to letter ballot. There were the usual objections as to such a move, both by railway men and private-car owners, and it was pointed out that many 30-ton cars may be of weaker construction than the lighter cars. But the weight of opinion was to the effect that these latter cars are a source of expense, trouble and danger.

TANK CARS—There is some controversy as to the handling and testing of the older tanks, and the committee did not favor the unrestricted transfer of such tanks to new steel underframes, especially where inflammable liquids are to be carried. The owners of such tanks desire a lower pressure test than the 60-lb. standard for new tanks, and the committee suggested a 40-lb. pressure for tanks built before 1903, but prohibiting them from carrying inflammable liquids. A "collision test" indicated that a tank which will stand 20-lb. water pressure without leaking will withstand the shocks acquired in transportation when filled with a liquid of the same viscosity as water.

CAR WHEELS—The subject of the contour of chilled cast-iron wheels in relation to frog and guard-rail flangeways has been submitted to this association and the American Railway Engineering Association by the American Railway Association, but the committee reported that there is not yet sufficient information as to the latest design of wheel to warrant any recommendations. It was stated, however, that the U. S. Bureau of Standards is about to make an investigation as to the manufacture and design of wheels of this class.

CAR TRUCKS—The committee had been instructed to submit limiting dimensions for cast-steel truck frames for 40-, 50- and 70-ton cars. As such frames are generally covered by patents it was considered impracticable to recommend definite designs, but limiting dimensions are necessary to provide for applying and interchanging the standard bolsters designed and submitted by the committee. The report will be sent to letter ballot but th section relating to truck springs will be referred to the committee on specifications and tests.

BRAKE-SHOES AND BRAKE -BEAMS—The committee reported the conclusion of the extended series of tests on brake-shoes at Purdue University, bringing the earlier tests into relation with the more recent tests at high speeds and pressures. It reported also that greater attention should be given to the hanging of the brake-beams, as a very large proportion of the defective beams removed show that the trouble is due to improper hang-

ing. This statement was strongly indorsed in the discussion.

COUPLERS AND DRAFT EQUIPMENT—The committee reported satisfactory experience with the road-service tests of the new experimental couplers, which prove to be much stronger than the present types. After considering the various designs submitted by manufacturers as embodying the requirements agreed upon between the committee and manufacturers, two were selected for the final elimination trial in service. In the discussion it was pointed out that railway officials should understand that while the new couplers are larger, heavier and more costly, they are a necessity to meet present-day traffic conditions.

CAR-DUMPING MACHINES—The committee reported that as a result of its 1913 report on the damage to cars by these machines, the manufacturers are modifying the designs and have prepared plans for necessary changes in existing machines. Further, it appears that no new machines of the solid-floor type will be built, all being of the movable platen type.

OTHER REPORTS—The reports of other committees were as follows: (1) Train brake and signal equipment; (2) safety appliances; (3) train lighting (design of axles carrying pulleys); (4) rules for loading materials on cars (including brick, drain tile, etc.); (5) inspection of box-cars; (6) specifications and tests of materials; (7) standards and recommended practice; (8) rules of interchange; (9) prices of labor and material for car repairs.

The officers for the ensuing year were given in our issue of June 25, 1914.

Storm Damage to Steel Structures at Duluth

The accompanying views show a part of the damage done at the coal docks at Superior, Wis., during the tornado of May 25, 1914.

Figs. 1-3 are views taken at the Northwestern Fuel Co., Dock No. 1, located on Superior Bay. Here the largest coal-handling bridge in the world was blown down by the wind and the rig is a total loss. The span of the bridge was 552 ft. with a height from the floor to the top chords of about 140 ft. Fig. 1 shows the huge bridge standing before the storm. This view was taken in June, 1913, while the construction work was going on and when most of the falsework was in place. The bridge was designed and built by the Heyle-Patterson Co., who have already been awarded a contract for a duplicate machine to replace it. Fig. 2 shows the destruction at the shear end of the bridge and the manner in which the steamer "Wm. A. Rogers" was pinned under the apron. The operator of the bridge was just hoisting the bucket, which was located at the left of the view, out of the hold of the boat when the bridge started to move, and when it fell he was caught under the wreckage and almost fatally injured. Fig. 3 shows the manner in which the pier end of the bridge fell and gives a clear view of the way part of the trolley runway lies. The brakes, clamps and chocks held this end of the bridge, but under such an excessive strain the shear

FIGS. 1-3. NORTHWESTERN FUEL CO.'S DOCK NO. 1, SUPERIOR BAY, WIS.

(Fig. 1. View of coal-handling bridge before failure. Figs. 2 and 3. Coal-handling bridge after destruction by tornado of May 25, 1914.)

FIG. 4. WRECKAGE OF ISLAND CREEK COAL DOCK NO. 2, ST. LOUIS BAY, SUPERIOR, WIS.

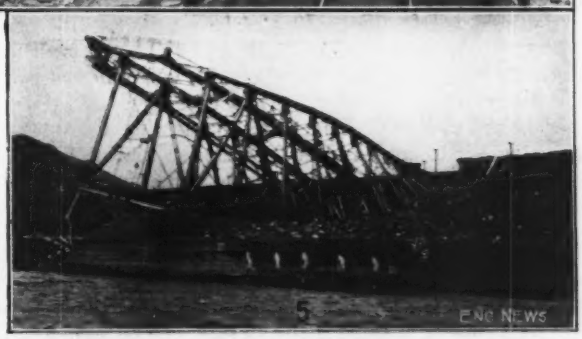


FIG. 5. WRECK OF NORTHERN COAL & DOCK CO.'S COAL-HANDLING BRIDGE, NORTHWESTERN DOCK, SUPERIOR, WIS.

nd moved for some distance before the whole structure verturned.

Fig. 4 shows wreckage at the Island Creek Coal Dock No. 2 on St. Louis Bay, Superior. The clamps and chocks n this case also could not hold the big bridge and it kidded for almost 25 ft. before going over. A duplicate f this bridge is to be built by the Brown Hoisting Machinery Co., of Cleveland, but none of the mechanism, tc., of the old rig can be used.

Fig. 5 is one taken of the wrecked bridge at the Northern Coal & Dock Co. dock, located almost next to the Northwestern Dock on Superior Bay. Here also the destruction is complete and it has been found impracticable o use either the steel or machinery in the reconstruction work.

The damage from the storm undoubtedly will run well over $500,000. The wind was from the southwest and although the Weather Bureau recorded a maximum velocity of 65 miles per hour, the extreme velocities must have been much greater than that in the storm path.

Progress on the Alaska Railway Surveys*

Eleven parties are now entering the field under the direction of the three commissioners, William C. Edes, Lieut. Frederick Mears and Thomas Riggs, Jr. It is planned to gather data over some 1100 miles of line during the summer season.

Six locating parties will make location surveys over the Seward-Fairbanks route via Susitna Valley and Broad Pass. A reconnaissance party will go over the route of the proposed Kuskowim extension via the Skwintna, while other parties will work in the vicinity of Knik and Turnagain Arms, Matanuska, Portage Bay and Seward.

The three locating parties between Broad Pass and Fairbanks will be under the direction of Mr. Riggs. Lieut. Mears will direct three parties in the Susitna Valley up to Broad Pass, and Mr. Edes will have charge of the parties adjacent to the coast. The headquarters will be at Ship Creek on Knik Arm and an office will be kept open at 1108 Alaska Bldg., Seattle, Wash.*

*From D. L. Reaburn, Locating Engineer, Skagway, Alaska.

The Railway Mileage of the World was 670,000 in 1912, according to a recently published report of the Prussian Department of Public Works. The western hemisphere contains more than half of this mileage; the United States, with almost 245,000 miles of railways, has no rival, Germany is second with 38,000 miles. Belgium, the most densely populated nation, has the highest record in proportion to area—47 miles of railways to 100 sq.mi. of territory. Australia, with the thinnest population of civilized countries, has the record in proportion to population. The United States has 6.92 miles of railways per 100 sq.mi.; while Europe has 5.63 miles per 100 sq.mi. Railway systems of the five great geographical divisions, compare in miles of operated line as follows:

	1912	1911	Gain
Europe	212,427	210,131	2,296
North and South America	343,557	333,376	10,181
Asia	66,483	65,107	1,376
Africa	26,478	25,103	1,375
Australia	21,578	20,089	1,489
Total	670,523	653,806	16,717

*For further data on the Alaska Ry. routes the reader is referred to "Engineering News," Mar. 20, 1913, containing an abstract of the report of the Alaska Railroad Commission.

Annual Meeting of the Society for the Promotion of Engineering Education

The 22nd annual meeting of the Society for the Promotion of Engineering Education was held at Princeton University, June 23-26. For many years this Society thought it necessary to hold its annual summer convention at the same place and at about the same time as some one of the national engineering societies, so that those of its members who desired to attend the national society convention might have a double inducement to attend. The experience at Princeton this year, however, proved that this society is entirely able to hold a successful convention by itself. Over 200 members were in attendance, and the regularity with which the daily sessions were attended and the active discussions which took place on most of the papers presented would have done credit to societies of much larger membership.

Most of the papers presented at the meeting, aside from the committee reports, had been printed in advance in the Society's journal, so that the time was spent in discussion and not in the reading of long papers. One or two excellent features in the conduct of the convention which we have never seen elsewhere are now followed by this Society and are well worthy of note by those interested in the successful conduct of engineering meetings. In giving out badges to those in attendance upon a convention it has become usual now to have the wearer's surname on the badge. We believe the American Society of Mechanical Engineers was the first society to start this custom a quarter of a century or more ago. The wearing of a surname printed in plain letters on a badge attached to the lapel of the coat has saved many thousand anxious moments without doubt to men who on recognizing a familiar face have searched their memories in vain for the name of the person recognized. The Engineering Education Society has now inaugurated an improvement on this excellent custom. The badges worn at the Princeton convention had marked upon them the wearer's initials as well as his surname, and also the name of the college with which he was connected or his place of residence. In practice this is found to add a great deal to the sociability of the members and to the facilities for making acquaintance. To read plain "Jones" on the lapel of a man's coat may not place him at all definitely, but to read "Ezekiel Jones, M.I.T.," at once gives information on which to hang conversation and acquaintanceship.

Another feature that adds very much to the interest of the discussion is the following: A large blackboard is placed at the front in view of the audience. As soon as a member rises to take part in the discussion, the Secretary writes in large letters on the board the name of the member and also the institution with which he is connected. Among the features of the meeting were a series of papers on "Methods of Teaching Mathematics," which evoked some striking differences of opinion, and reports of some recent experiments on the marking of engineering students according to their character and personal qualifications which have been made at the University of Cincinnati and at Purdue University.

Besides the technical program presented in the four days' session, various social events were arranged for the visitors' pleasure, including a reception by President and Mrs. Hibben, a lecture on the great meteor crater of Arizona, and the annual dinner of the Society on Thursday evening, at which the President, Dean Gardner C. Anthony, of Tufts College, delivered the annual address.

The following officers were elected for the ensuing year: President, Anson Marston, Dean of the Division of Engineering, Iowa State College, Ames, Iowa; Vice-Presidents, Henry H. Norris, *Electric Railway Journal*, New York, and C. Russ Richards, Acting Dean of the College of Engineering, University of Illinois, Urbana, Ill.; Secretary, F. L. Bishop, Dean of the School of Engineering, University of Pittsburgh, Pittsburgh, Penn.; Treasurer, William O. Wiley, John Wiley & Sons, New York; members of the council, R. H. Fernald, A. H. Fuller, A. M. Greene, Jr., E. V. Huntington, Vladimir Karapetoff, D. C. Miller, W. M. Riggs. The reports of the various officers showed that the society is in a flourishing condition; the individual membership is now nearly 1400 and the institutional membership about 50. The council recommended that the 1915 meeting be held in the Middle West.

Annual Convention of the American Institute of Electrical Engineers

The 31st Annual Convention of the American Institute of Electrical Engineers was held June 22 to June 26, at the Hotel Pontchartrain in Detroit. In the annual address by President C. O. Mailloux at the opening session, Mr. Mailloux congratulated the Institute on the extraordinary progress which had carried it, the youngest of the great National Engineering Societies, to a position where it could claim precedence not only in number of members and of local sections, but also in the importance of its technical work.

The field of electrical application is rapidly enlarging, and unless this enlargement should result in a loss of solidarity through the splitting off of societies of a too specialized character, the greatest work of the Institute is still before it.

President Mailloux then spoke at length upon the duties of the engineer to society. The engineer has been prone to regard his duties with too narrow a vision. Not enough emphasis has been placed upon the broader development which would fit the prospective engineer for the position he should hold in the public life.

In recent years no other profession has had so profound an influence upon the advancement of civilization as has that of the engineer, but he has been too busy with the details of his task to realize his mission or to impress it upon the public mind.

The public has long since come to demand the services of a jurist in important judicial positions and of a physician when questions of health and sanitation are under consideration. It is equally necessary that its engineering problems be solved by engineers. Now its engineering commissions are largely filled with lawyers, politicians and merchants. This situation must be changed. Every year, with the increasing complications of modern life, there is more and more need for the engineer at the helm.

Mr. Rushmore, of Schenectady, in discussion of the address, said that the engineer instead of being on the Public Service Commissions and in the responsible civic po-

itions where he should be was now usually employed to serve and instruct the laymen Commissioners and public officials. The man who knows and is competent is too often under and dominated by the man who does not know and is incompetent.

The first technical paper of the session was upon Electric Heating as Applied to Marine Work. The authors were Lieutenant C. S. McDowell and D. M. Mahool, who have been conducting extensive tests upon this subject for the Navy at the Brooklyn Navy Yard. It was brought out in the paper and the discussion that for most cases the radiant heater depending upon the radiation from large lamps or red-hot wire was most satisfactory and efficient, and that for moderate temperatures and auxiliary heating, the cost of its operation was not prohibitive. However, as showing the impracticability of using electric heat for general use, it was shown that at five cents per kilowatt-hour the cost for heating a medium-sized house would be about $2000 per annum, using the data given in the paper. An interesting point also brought out in the discussion was that furnaces given a coat of whitewash would have a higher surface temperature but would radiate less heat than those unpainted.

Perhaps the most noteworthy development in the application of electricity which was described at the convention was that of the gyroscopic compass as described in the paper of H. C. Ford, of Brooklyn, N. Y. This application of the well known gyroscope has been developed by a pioneer electrical inventor and a charter member of the Institute, Elmer A. Sperry. The compass requires no corrections such as are necessary with the magnetic compass and it is absolutely permanent. Its use has become general in the navy and it is beginning to be adopted by the merchant marine. The successful use of large gyroscopes for stabilizing boats and preventing their rolling was also described and several other uses were touched upon.

The evening session on Tuesday was under the direction of the Industrial Power Committee and the Chairman, Rudolph Tschentscher, of the Illinois Steel Co., South Chicago, presided. Three papers were read, all relating more or less to the steel industry.

Direct-current motors for coal and ore bridges by R. H. McLain of the General Electric Co., Schenectady, gave valuable technical data with regard to the characteristics of motors for this use and their operation. Mr. McLain took up particularly the relative values of acceleration and running speed needed for various length and times of travel. The trolley accelerations vary from 1.5 to 2.5 ft. per sec. and car speeds run as high as 1500 ft. per min. Series motors with dynamic braking are used, though a weak shunt field may be added to accelerate the braking action. For hoisting, use is made under varying conditions of either series, compound or shunt-wound motors, the series being used for the lowest and the shunt for the highest speeds. On low-speed hoists, dynamic braking is used in lowering the empty bucket.

Transmission Lines

On Thursday morning a meeting was held under the direction of the Engineering Data Committee with P. H. Thomas, Consulting Engineer, of New York City, Chairman. "Data relating to high-tension transmission systems" was the subject of a subcommittee report which was prepared by Mr. Thomas. It is an analysis of the reports made by 25 power companies in reply to inquiries sent out to about one hundred companies operating at 25,000 volts or over. Those reporting included six companies working at 100,000 volts or over, 4 at about 85,000 volts, 10 at about 60,000 and 4 at 25,000 to 50,000 volts. One of those now rated at 85,000 is designed to eventually operate at 140,000.

A large collection of valuable technical data concerning the characteristics and operation of high-tension lines was given, largely in tabular form. Some points of general interest are the following: although one span on the lines of the Pacific Gas & Electric Co. is mentioned as of 4427 ft., the largest span described is 3200 ft. in the line of the Mississippi Power Co. and crosses the Missouri River. A steel core cable is used and the highest tower is 230 ft. The greatest total mileage is that of the Pacific Gas & Electric Co., California, with 1260 miles. Standard tower spans vary from 400 to 800 ft. Very little deterioration of any kind was reported, though it was brought out in the discussion that one Western company had just discovered bad pitting of the copper wires at certain points where in contact with the insulators. This line had been in use 11 yr., most of the time at 60,000 volts. Nearly all companies work on one of two lines on the same pole or tower while the other line is alive. Eleven companies use preservative treatment on their wooden poles at costs varying from 10c. to $1.50 each. The largest line-charging current reported is 250 amperes at 60,000 volts by the Pacific Gas & Electric Co. Nearly all companies have telephone lines on the same poles or towers as the power lines.

Power Plants

Wednesday afternoon the meeting was presided over by H. G. Stott, Chairman of the Prime Movers Committee and Superintendent of Motive Power of the Interborough Rapid Transit Co. The paper presented jointly by him and Messrs. W. S. Gorsuch and R. J. S. Pigott, both of the Interborough Company, was, on account of Mr. Stott's reputation as an authority, one of the most anticipated of the meeting. Its title was "The Present Status of Prime Movers."

Six subdivisions were given as follows: (1) Reciprocating steam engines; (2) steam turbines; (3) gas engines; (4) oil engines; (5) hydraulic turbines; (6) Finance and economics.

The reciprocating steam engine was disposed of in half a page as not to be considered except in very small sizes or under unusual conditions. Prime movers are to be compared as to (a) capacity, (b) efficiency, (c) weight and (d) price. Taking up first capacity and efficiency, the writers criticized the steam consumption per kilowatt-hour as being unsatisfactory when not accompanied with data as to steam and vacuum conditions. They advocate a wider use of the efficiency ratio (Rankine cycle), which is a measure of the excellence of design and which differs much less among modern turbines than the varying water rates would lead one to suppose. Curves showing the rate of steam consumption taken from actual turbines up to 30,000 kilowatts showed a minimum water rate about 12¼ lb. for a 60 cycle; 80% power factor; 175 lb. pressure; 100° F. superheat and 28.5-in. vacuum, which are taken as standard conditions. At 15,000 kw. the rate is only a small fraction of a pound higher, but below this size the rate goes up rather rapidly.

The best water rate should, for most purposes, occur at 75 to 85% of the maximum 24-hr. rating.

Curves showing Rankine-cycle efficiency ratios, with a maximum of 77% and thermal efficiency with a maximum of 20%, were given. These curves were nearly flat throughout the upper half. A similar curve for pounds per kilowatt brings the weight for 30,000 kw. down to 30 lb. per kilowatt as a minimum, and is a straight line to 15,000 kw., where the figure is 35 lb. per kilowatt. Again, the lowest cost per kilowatt ranges from about $6.60 at 15,000 kw., to $6.20, at 30,000 kw.

Taking up the gas engine, the statement is made, that over 75% of the gas-power machinery, is used with blast furnaces and natural gas. Blast-furnace engines have reached a capacity of 6000 b.hp. for a single unit of the twin-tandem type. The gas engine has an efficiency curve which rises continually to its maximum load, and thus has no inherent overload capacity. The gas engine has the advantage of fairly uniform thermal efficiency for all sizes, and this may be taken as 23.8% on a basis of kilowatt-hours at full-load rating (25.2% for brake horsepower). Guaranteed fuel consumption varies from 13,500 to 19,200 B.t.u. per kw.-hr., for producer gas, with a somewhat wider range for natural gas, and 15,000 B.t.u. for blast-furnace gas. In the matter of weight, the high temperatures and pressures involved, place the gas engine at a disadvantage when compared with steam engines. Weights are given up to 1500 kw., where the average weight per kilowatt is 740 lb., as against 58 lb. for a 3600-r.p.m. turbine. Moreover, the weight per kilowatt of the gas engine increases with size. On account of the great weights, the costs also, of gas engines are high. The curves given show an average cost for 1500 kw.-units as $71.60 per kilowatt.

There are approximately 300 installations of medium and heavy-duty oil engines in the United States, aggregating over 75,000 hp. The largest of these is 450 b.hp., although in Europe 2500-hp. Diesel engines have been built. For 19,000-B.t.u. oil, a curve is given, showing a full-load efficiency of 28.2%, on the basis of electrical output (auxiliaries not allowed for). For a 400-kw. vertical Diesel engine, the pounds per kilowatt are 750, and the curve is nearly horizontal, though it rises rapidly for the lower capacities. The cost per kilowatt, is given as $95, though the data for this figure are limited.

The best efficiencies now obtainable from hydraulic turbines are slightly over 90%. Much improvement has been made in the power per unit weight. Recent progress is toward the use of single-runner vertical-shaft turbines for low and medium heads. Weights and costs are not strictly comparable with steam and gas equipments, on account of the influence of difference of head in the case of water power.

Under the head of "Finance and Economics," a comparison is first made of different heat engines and curves are drawn, showing the comparative costs at different percentage loads of 750 kw.-units. From these curves, the following data may be derived:

	Cost per kw.-hour, mills		
Per cent. of load	25%	50%	100%
Steam turbines	6.3	4.2	3.2
Gas engines	9.5	5.2	3.2
Oil engines	12.0	7.0	5.0

A similar set of curves is given for the comparison of one 20,000-kw. turbine, ten 2000-kw. gas engines and forty 500-kw. oil enginets, the power in each case aggregating 20,000 kilowatts. This case is naturally still more favorable to the turbine. The cost figures at full load are: turbine, 2.1 mills; gas engine, 3.2 mills; and oil engine, 4.7 mills. In these figures, coal is taken at $3 per ton, for both turbine and gas engines, and oil is figured at four cents per gallon. Attention is called to the unsuitability of gas engines, hydraulic turbines or other apparatus with high-investment charge for carrying short-time-peak loads. The fact is also noted that the largest turbines have now surpassed the best gas engines in fuel economy at high-percentage loads. Emphasis is placed upon the reliability and low maintenance of the steam turbines, and upon their great space economy.

Cables

A paper on voltage testing of cables, by W. I. Middleton, of the Simplex Wire and Cable Co., of Cambridge, Mass., and C. L. Dawes, of Harvard University, was a highly technical discussion of the conditions met with in testing cables.

In discussing the paper, Mr. Stott stated that all the cables of the Interborough road were tested with 2½ times normal voltage at least once a year, and many of them oftener.

Edison Medal

On Thursday evening occurred the presentation of the Edison medal, always one of the most interesting events of the Institute meetings. Funds for this gold medal were provided by a number of Mr. Edison's friends on the occasion of his 57th birthday. This year, the fourth time that it has been awarded, it was given to Charles F. Brush, of Cleveland. Before making the presentation, President Mailloux sketched at some length the early history of electrical development, with which Mr. Brush was closely associated.

To show what an advance Mr. Brush had made in electric lighting Pres. Mailloux describes one of the earliest installations of arc lights where ten lights were arranged around Madison Square, each lamp being driven by a separate generator taking 2 or 3 horsepower each. It was such a condition as this, which impressed upon Mr. Brush the necessity of a better method for the operation of lamps and which led to the successful development of the series arc-lighting system. In 1881 there was exhibited at the International Exhibition at Paris, Brush apparatus built by the English Brush Company.

It was not until 1882 that the first constant potential Edison central station was built on Pearl St., New York, and already at that time hundreds of stations for the production of arc lighting were in operation all over the country. These were all very small, usually not over 15 or 20 lamps at the largest. A 50-hp. engine was a large one. The 150-hp. engine at the Pearl St. Station was mammoth. At that time, the rivalry between the Edison and the Brush system was most severe, and Pres. Mailloux called attention to the changed conditions which now after thirty years, bring it about that Mr. Brush is receiving the "Edison" medal.

Ultra-Violet Rays

On Friday morning a paper on the sterilization of water by ultra-violet rays of the mercury vapor quartz lamp, was given by Mr. von Recklinghausen, Director of the Westinghouse Cooper-Hewitt Co., Paris, France. It

found that all the dangerous bacteria, and all their res succumb to the ultra-violet light, if exposed to it ongly enough, for even a fraction of a second. To ob- n the use of all the light, the lamp must be surrounded the water, but it is found that if the water comes in ntact with the tube of the lamp itself, the activity is eatly reduced. Also since glass is opaque to the ultra- olet rays, only quartz can be used between the tube and e water. Stirring up the water in its passage through e tank is necessary, to prevent the bacteria from hiding hind particles of the matter in the water and escaping. ne largest plant now in use is at Luneville, France, and s ten lamp equipments. The water as fed to this out- , has a germ content, sometimes as high as 1000 per .; on leaving, the bacterial content is reduced down to om 0 to 10. There has been a great reduction in the phoid-death rate in this place, the old rate ranging om 70 to 160, balanced against almost no deaths at all, the present time. The energy consumption is very nall; the largest lamp in use takes but 2½ amperes at 0 volts. From 50 to 130 kw.-hr. per million gallons is liberal estimate of the power necessary. In answer to uestions which came out in the discussion, Mr. von ecklinghausen estimated the cost at about 60c. per mil- on gallons, including power at 1c. per kw.-hr. and lamp enewals at 30c. per million gallons. The water must ot be too turbid, so that the light will be too soon ab- rbed by it. The Luneville plant has been in operation ree years, and purifies 200,000 gallons per day.

The afternoon of Friday was devoted to a conference f the section delegates. There are at present 30 sec- ions, and 48 University branches. The traveling ex- enses of the section delegates are paid, and nearly all he sections were represented at the meeting. Among ther things, a resolution was passed, asking the Board f Directors of the Institute to define more exactly the elation of the section delegates to the affairs of the In- titute.

The attendance was nearly 500, and the convention will ong be remembered as a most successful one.

The Ficklen Patent on Steel Expansion Joints for Concrete Roads

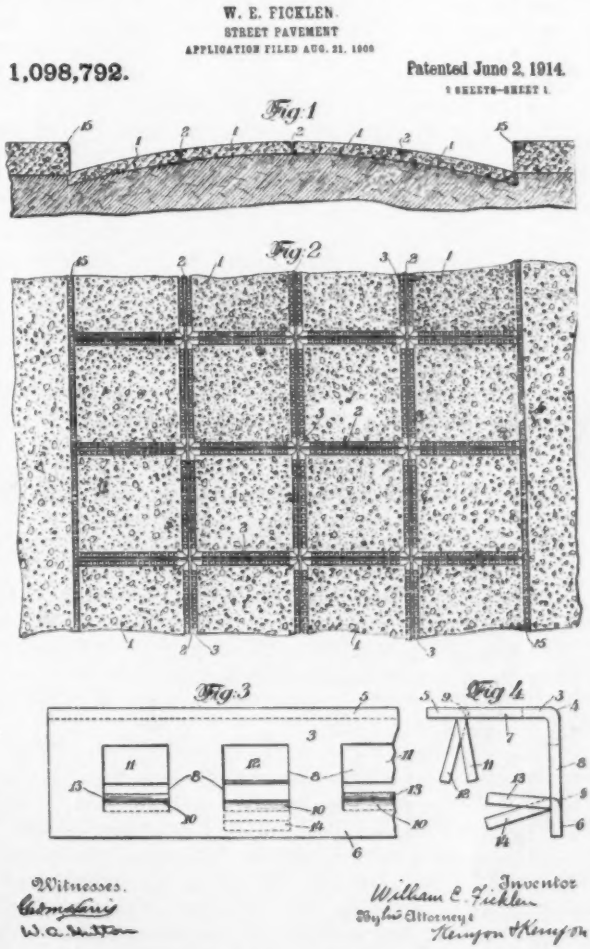
Letters have recently been sent out by the firm of Moore & Clark, Patent Attorneys, of 2 Rector St., New York City, addressed to various State Engineers and others demanding royalties on concrete pavements or roadways on account of a patent issued June 2, 1914, to Wm. Ficklen, of 2 Rector St., New York City. The letter states that "the patent broadly covers a concrete pavement supported on an earth bed and formed with expansion joints armored at their upper edges."

While the Ficklen patent was issued on June 2, the original application was filed Aug. 21, 1909. The attorneys claim that Ficklen's invention antedates the inventions of Baker, Kahn and others who have for some time been making and selling steel material for expansion joints in concrete roads, and that those who have purchased and used such joints, therefore, are subject to suit for the collection of royalties.

By the courtesy of the patentee and his attorneys, we have been permitted to examine the record of the case before the Patent Office. This record is extremely voluminous. During the five years since Ficklen filed his original application, his case has been in the hands of several different firms of patent solicitors, and the records show over forty different actions by the Patent Office before the case was finally allowed.

The patent undeniably contains broad and sweeping claims. They are typified by Claim 1, which is as follows:

1. A pavement comprising an earth roadbed, a crust supported directly on said roadbed and comprising a plurality of concrete sections of relatively large area separated from each other by expansion joints extending from the top of the pavement to the roadbed, and reinforcing means embedded in and carried by and continuing along the upper portions of the edges of the concrete sections at the joints which require reinforcement.



FACSIMILE OF MAIN PAGE OF ILLUSTRATIONS OF U. S. PATENT NO. 1,098,792

We reproduce herewith the first sheet of drawings of the Ficklen patent (which is No. 1,098,792). It will be noticed on this drawing that Ficklen originally contemplated dividing up a roadway into blocks about the size of ordinary sidewalk slabs. The words "relatively large area" did not appear in the broad claims filed with the original application, but were added in some of the numerous amendments. Possibly it was thought their addition would better sustain the claim that the construc-

tion shown and described applied also to concrete roadways with transverse joints spaced 20 to 40 ft. apart.

Referring to Claim 1, its validity rests on the question whether Ficklen was the first to combine with the expansion joint (or dividing plane) of a section of concrete pavement, "reinforcing means embedded in the upper edges of the concrete section," and further whether such a combination constituted an original invention in view of the state of the art of reinforced-concrete construction in 1909.

The Patent Office examiners long opposed both of these contentions by the applicant's attorneys, and again and again rejected all the claims, citing numerous prior patents in support of their position. Not until very recently did the office finally recede from its position and allow the broad claims above referred to.

It is not, of course, our function to act as expert advisers to pass upon questions of the validity of patents. It is proper for us, however, to point out that in view of the long opposition of the Patent Office to the issuance of this patent, it is likely that the courts might take a similar view of it, should the threatened court proceedings for its infringement be carried into effect. Certainly the record of prior patents cited by the Patent Office, easily obtainable from the office files and very possibly prior use of steel reinforcement not on the Patent Office records, should furnish plenty of ammunition for those who prefer to fight such a suit rather than pay royalty.

Failure of Coffer-dam at Dam No. 1, Mississippi River St. Paul

Telegraphic reports from George W. Freeman, U. S. Assistant Engineer at St. Paul, state that on June 29 a portion of the mid-river coffer-dam used in building Dam No. 1 across the Mississippi River near St. Paul, Minn., was washed out under exceptionally high water for this time of the year.

Lock and Dam No. 1 are being built by the United States Government for combined power and navigation purposes. The work comprises the reconstruction of an old lock and the construction of a reinforced-concrete powerhouse and hollow reinforced-concrete dam across the river. The powerhouse and lock have been completed and a portion of the dam has been built within a coffer-dam. The river had then been turned through sluiceways in the completed portions and the mid-river section of the dam was being built within another coffer-dam, comprising upper and lower barriers.

The dam crest is to have elevation 743.5 (Cairo datum), but this was designed for the high-water period, which normally does not come at this time of the year. The coffer-dam had a top elevation of about 732. On June 8 the river rose to that elevation and flooded the dam. It continued rising steadily until June 29, when an elevation of 736.8 was reached and water was flowing over the entire length of the coffer-dam. At 2:30 p.m., June 29, the longitudinal section of coffer-dam between the main dam and the sluiceways failed, and in 15 minutes there was an 80-ft. gap. The lower barrier of the coffer-dam was washed away, but the main section of the upper barrier is intact. Three sections of the partially completed reinforced-concrete dam (which was of a peculiar unit construction type) were undermined and n[illegible] lean upstream. These may be a total loss. There w[illegible] several narrow escapes downstream from the dam, b[illegible] no lives were lost.

Notes from Engineering Schools

University of Kansas—A correspondence course in water filtration and pumping will be given as state extension work. Prof. C. A. Haskins, as state sanitary engineer, found the men in charge of the water works of smaller cities inexperienced and without technical knowledge of the works.

Massachusetts Institute of Technology—Electrical engineering research has developed very rapidly during the past year and a noteworthy extension of the laboratory organization has recently been effected (aided by the coöperative agreement between Harvard University and the Institute of Technology whereby the two departments of electrical engineering were practically merged). There has been created, a research committee to whom reports are made upon the progress of the various researches. The committee comprises (1) those members of the electrical engineering department staff who are supervising or actively engaged in research work; (2) those men who are personally carrying on research work in any branch of the department, and (3) those who have completed a reorganized piece of research work during the preceding year. The research committee, as a whole, will meet once a month during the school term, such meetings being open to all members of the department staff. By this arrangement, the research activities of the department will be brought into close relation with the regular teaching work. Thus, any member of the staff, whether professor, instructor, or assistant, who desires to carry out any original investigation may become identified with the research work through the research committee. Some of the special resources of the research laboratory which have not been designated for use in a particular investigation may be used in providing such a man with apparatus and other laboratory facilities. Even if a member of the department staff is not able to devote a considerable portion of his time to an experimental investigation, he still has the opportunity of offering suggestions upon the conduct of investigations which are being made by others.

The staff at present includes six research associates and assistants who give their whole time. This number will be increased to nine on July 1, 1914. In addition to the work of these men, who are appointed by the Institute, the theses of four students who are candidates for advanced degrees in electrical engineering have been carried on in the research laboratory during the past year. An amount of over $20,000 is available for salaries, apparatus and other expenses in connection with the work of the research laboratory and library during the next year.

Massachusetts Institute of Technology—The Institute has accepted the recommendation of the Alumni Council in regard to the establishment of a new four-year undergraduate course—one in science, engineering

and business administration as outlined in ENGINEERING NEWS, Sept. 11, 1913, p. 578. This will be open in the regular program of the fall of 1914.

NEWS NOTES

A Private Water Tank Exploded during a fire in a residence in Walsenburg, Colo., on June 21. The tank was located in the attic.

An Earthquake in Southern Sumatra is reported to have caused widespread damage on June 26. Sumatra possesses a number of volcanoes. It is the largest island except Borneo of the Malay archipelago.

A Steamboat Damaged the Appoquinimink Bridge on her trip from Philadelphia, Penn., to Odessa, Del. The captain of the "Clio" is reported to have stated that he saw a white light on the bridge and supposed the draw span was open.

A Heavy Premature Quarry Blast, at the Melrose Granite Co.'s quarries, 3 mi. from St. Cloud, Minn., on June 23, killed one man and seriously injured three others. The four men were charging a "lift hole" 17 ft. in depth. The foreman was tamping the powder when the explosion occurred.

The S.S. 'California" Went on the Rocks of Tory Island, Ireland, in a thick fog, on June 28. No lives were lost; the 1016 passengers of the "California" of the Anchor Line, bound for Glasgow, were landed at Londonderry on June 29. Two British destroyers early on June 29 stood by as long as needed.

A Lifeboat Broke Away from Its Davits while loaded with passengers of the "Gothland," the Belgian steamship which was recently wrecked on the Scilly Islands, and fell 30 ft. into the sea. The bottom of the lifeboat was smashed, and all of the occupants were thrown into the water, but were rescued.

A House Slid Into an Adjoining Excavation for a moving-picture theatre in Brooklyn, N. Y., on June 23, seriously injuring two persons. While tearing down a cellar wall the adjoining house sagged, and the third floor and part of the second fell into the cellar. According to reports the house had not been shored.

A Steamer Was Wrecked on a Water-Works Intake Crib at the Chain of Rocks, St. Louis, Mo., on the night of June 24. It was claimed that rivermen were not notified of the construction of the crib, and further that the crib was equipped with lamps at the corners, only 4½ in. in diameter, visible only 200 yd. away. Divers found that the crib was uninjured, but that the "Majestic" had a hole in her hull, 30x3½ ft. It is probable that when the river lowers to a workable stage, the hole will be temporarily covered, the hull pumped out, and the vessel floated to Cairo for repairs.

Gas in a Deep Cesspool in East St. Louis on June 23, caused the death of the contractor who had built the cesspool, and of two other men. The contractor, discovering that a tool had been left at the bottom of the pit just completed in the rear of a grocery store, started down a ladder to recover it and was overcome by gases and fell into about 6 ft. of water. One after the other, two assistants who attempted to rescue him were overcome and fell. A fourth man was pulled back unconscious, before falling. The pit was 22 ft. deep by 18 ft. in circumference and connected to an old cesspool. It is supposed that the fumes came through the connecting pipe after the water in the old pit had run into the new. A lighted lantern is said to have been extinguished by the fumes.

The Salem Fire—At a little before 2 p.m., on June 25, a fire was discovered in a brick and wood factory building of the Korn Leather Co., in the leather and shoe district of Salem, Mass., which spread rapidly until an area of about 2 sq.mi. had been devastated. The damage is estimated at about $12,000,000. The original blaze moved eastward and westward with broadening front, before a brisk wind. First, a section of small frame residences and then the more important residential district in the western portion of Essex and Broad Sts., were destroyed.

Within an hour flying embers had started other blazes, in South Salem, and about 9 p.m., a third fire broke out, in North Salem, about 1½ mi. from the starting point of the original fire.

More than 1000 buildings, including a score of factories in the shoe and leather district, were destroyed and about 15,000 persons made homeless. The fire burned itself out on June 26. Seven persons are known to have died. Martial law was established at 9 p.m., June 25.

In addition to the Salem fire department, the neighboring cities and towns responded with fire apparatus and men; but the burning area was too great, the building construction too inflammable, and the water supply inadequate, to make resistance effective.

Structural conditions at Salem were as follows: Frame dwellings with out-buildings may be erected within the fire limits, but were restricted to 40 ft. in height and 2000 sq.ft. in area, if within 8 ft. of any other wood building. Frame tenements or lodging houses of over 30 ft. frontage must have a brick division wall. The height of frame tenements or lodging houses within the fire limits is restricted to 48 ft.

In the principal mercantile district about 75% of the construction is joisted brick, and the remainder frame. Heights vary from two to four stories.

The Pacific Great Eastern Ry. is rushing construction on its line between Vancouver and Fort George, B. C. The Squamish section is 93% completed, and track has been laid to within 20 mi. of the Pacific Coast terminal. Over 5500 men are now engaged on the construction work.

Brick Roads in Cuyahoga County, Ohio, will be increased 60 miles in length during the present season, according to the plans recently announced by the County Engineer. There are already about 400 miles of brick pavement in the county. A minimum width of 16 ft. has been adopted for the new roads. The present season's work will amount to about $900,000.

The Snake River Viaduct of the Oregon-Washington Ry. & Navigation Co., at Perry, Wash., is a steel structure 4500 ft. long, with its rail level 300 ft. above the water. The middle portion consists of five truss spans of 240 ft.; the remainder has 23 plate-girder spans of 60 ft. for the towers and 80 ft. for the intermediate spans. The bridge is expected to be completed this year.

Uniform Building Law for San Francisco Bay Cities—The mayor of Berkeley, Calif., has requested the coöperation of the executives of the cities surrounding San Francisco Bay in adopting a uniform building ordinance. At the present time there are many dissimilar clauses in the various ordinances, which prove a source of annoyance to engineers, architects and contractors whose practice is not confined to one city.

A Speed of 300 Miles an Hour has been claimed for a miniature electric railway system recently exhibited in England, and known as the Bachelet levitated flying train, the train being entirely unsupported during its travel. The inventor's modest claim has been easily outdone by another foreign inventor who claims that his system will give a speed of 500 miles per hour. The Bachelet inventor is pleasantly disposed of in the "Railway Engineer," of London, as follows:

This interesting scientific toy is by no means new, as it was exhibited in the United States in 1912, but because the "experts" who write about such things in some of the daily and weekly papers had apparently never heard of it they thought they had seen a new wonder of the world, and became temporarily (we hope) demented, and gushed out the most dreadful nonsense about trains traveling at a speed of 300 miles an hour. The idea is that the car or container is raised off the track by magnetic repulsion and then sucked along by solenoids. The whole scheme, whether for parcels or passengers, is fantastic, and from a commercial and practical point is not worth a second thought.

Constructing a Filter Plant by Day Labor was one of the features of the new sewage-disposal plant at Aberdeen, S. D. (12,000 population), described by W. G. Potter in a paper read before the Western Society of Engineers. The plant includes a sedimentation tank, sludge filter, siphon chambers, sprinkling filter and final settling basin. The total cost will be about $130,000. Labor was paid 22½c. per hour at first, but for most of the work the rate was 25c. per hour, and labor was very hard to get during the summer and fall seasons. Carpenters on form work were paid 35c. to 45c. per hour, and brick masons 70c. to 80c. per hour. The entire work except part of the excavation, part of the pipe hauling, and the construction of the pump-house superstructure, was done for the city commissioners by city forces, without contract, Mr. Potter being the designing and constructing engineer. He states that it is a good example of nonpolitical municipal work, and that politics was one of the incidental troubles that was entirely absent from this work.

The Plan to Sell the United States Battleships "Idaho" and "Mississippi," which was recently abandoned by the House and the Navy Department, was approved by the former body on June 23. The House reversed its former action and accepted in substance the Senate's amendment. The vote was 174 to 87, showing a remarkable change in sentiment. These

two vessels will be sold to Greece for their value new, and the proceeds devoted to the purchase of a superdreadnought.

Paving by Municipal Day Labor in Duluth, Minn., as noted in our columns of May 21, 1914, p. 1158, is proving very successful according to the Duluth "Herald" of June 18, which states:

James W. Preston, superintendent in charge of the paving of West Superior St., between Fifteenth and Thirtieth Aves., is receiving a great deal of praise from merchants for the method in which he is pushing the paving work. The business men say that not only is the city saving considerable money on the job by having the work done in this manner, but is also getting a better job done.

Highway Repair Work in Pennsylvania has received a fresh impetus from a recent decision of the Dauphin County Court which releases $1,028,665, the accumulated money derived from automobile licenses, and places it at the disposal of the State Highway Department. Money for state road work has been scarce in Pennsylvania since the failure last fall of the proposed $50,000,000 bond issue to pass the referendum; and the highway engineering staff has been threatened with disintegration.

Coöperative Drainage Work is being carried out by the U. S. Department of Agriculture and the University of California. As a first experiment in the reclamation of land formerly highly productive under irrigation and covered with profitable vineyards, orchards and alfalfa, but now given up to alkaline barrens or Bermuda grass pasture, 160 acres of badly alkaline land at Kearney Park, near Fresno, will be taken in hand. This land belongs to the University of California. The field work for this investigation is in charge of Walter W. Weir, U. S. Drainage Engineer, Berkeley, Calif.

Motor Cars Have Displaced Steam Trains on the Central New York Southern Ry., a 39-mile line extending between Ithaca and Auburn, N. Y. The cars are of the gasoline type, with a 200 hp. engine mounted on the leading truck and driving the front axle direct (or through gears for slow speed). They are 70 ft. long. The semicircular rear end has a door for communication with trail cars. Other features are a conductor's brake valve and whistle lever (pedal) at the rear end, for use in backing, a pneumatic gong ringer, steam connection for heating, and the Warner register, which registers the mileage of each trip as well as the total mileage run. The cars were built by the McKeen Motor Car Co., of Omaha, Neb.

The Coming extension of Auto-bus Service is indicated by the fact that nine applications for approval of auto-bus lines were scheduled for hearing before a member of the Public Service Commission, Second District, at Albany, N. Y., on June 24. The names of the applicants and the proposed routes were as follows: E. L. Aley, Durhamville to Oneida; Wm. R. Garrison, Palenville to Saugerties; Frederick A. Flick, Kingston to Saugerties; Erastus D. Bean, St. Regis Falls to Malone; Fred Wohlleben, of Norwich, Canastota to South Bay on Oneida Lake; Wm. Amell, Plattsburgh to Redford, Clinton Co.; W. C. Smith, Hilton to Charlotte, Monroe Co.; J. F. & W. A. Lilly, Durhamville, Oneida Co., to Oneida, Madison Co.

Cement Gun Operators Are Not Plasterers according to a recent decision of the Supreme Court of Massachusetts. On petition of the New England Cement Gun Co., the court ordered a decree restraining the officers and members of the Operative Plasterers' International Association of the United States and Canada, Union No. 10, Boston Branch, from causing or taking part in any boycott against the plaintiff's business. The defendants were also restrained from causing or inciting any sympathetic strike against the plaintiff or its customers for the purpose of preventing the use by the plaintiff of its machinery or for the purpose of compelling it to discharge any of its nonunion members.

The specific case involved was the construction of the Old Colony Real Estate Trust Building in Boston. The interior plastering contractor, whose workmen were members of the plasterers' union and were applying plaster by the usual hand methods, was hampered by strikes called because the outside stucco contractor was not employing union plasterers at the cement gun used on this stucco work. These strikes became so frequent and annoying that the owners finally canceled the stucco contractor's contract. Hence the suit.

The Investigation of the "Empress of Ireland" Disaster by a Maritime Court at Quebec, which was concluded last week has been conducted with care and thoroughness, and it has been established that the collision of the "Empress of Ireland" and the collier "Storstad" was due to the fact that a blunder was made, for when the vessels first sighted each other they were more than three miles apart and were traveling on courses which would have allowed them to pass in safety. The fog hid the vessels from each other shortly afterward and the Court will have to sift out from the mass of conflicting testimony whose was the act that brought the two vessels into collision.

The very short time in which the "Empress of Ireland" remained afloat after her side had been pierced by the "Storstad" bow is explained by the fact that the doors through the water-tight bulkheads were open when the collision occurred. There was no means by which they could all be closed simultaneously from the Captain's Bridge, and the steward whose duty it was to close the doors had no time to do so after the collision, although some doors were closed. There has been no thoroughly satisfactory explanation of the excessive list of the vessel as she sank. It is thought, however, that one of the boilers may have broken from the mountings by the collision and rolled to the side of the ship, and as the vessel listed more water would come in through open port holes.

A Neighborhood Center Planning Competition is to be held under the direction of the City Club of Chicago. The object is to show the desirability of and possibility of developing the city as a federation of neighborhoods, but not to the extent of isolation. While an enormous amount of trade is scattered through Chicago, local business suffers from the lack of district trading points and the local trading centers are not distributed according to any plan, but rather by casual influences. This lack of definite arrangement applies also to such social institutions as schools, post offices, police and fire stations, playgrounds, libraries, social settlements, chuches, etc. The city's population averages 12,258 per sq.mi., with 71,500 and 3055 as the maximum and minimum. For the residential area, the average is 16,000 and the maximum 93,000 per sq.mi. There are unbuilt areas of 50 acres to ½-sq.mi. in the outer sections, and about 35% of the whole area of the city is still vacant, while the residential districts represent about 35% also. Competitors will reach their own conclusions as to what institutions to include in their plans, and the plans need not apply specially to Chicago. The preliminary competition will close Nov. 9, and a jury will select a number of the best plans, whose authors will enter a final competition closing Jan. 25. An exhibition of the plans will be held in February. Further information may be obtained from George E. Hooker, Civic Secretary, City Club, 315 Plymouth Court, Chicago.

Panama Canal Fender Chains—Three sections of fender chain, two of which were 158 ft. long, and one of which was 110 ft. long, all three making one complete chain, 426 ft. in length, arrived on the Isthmus on June 10, on the steamship "Tenadores." One chain is being installed between chain fender machines Nos. 824 and 825 at Pedro Miguel Lock, to protect the intermediate gate in the east chamber. With the delivery, 3⅜ complete chains, out of the 24 required, have reached the Isthmus. Fifteen have been manufactured, most of them now being under test in the United States. The delivery of the chain-operating machinery, built by the United Engineering & Foundry Co., has been completed.

The chain fenders are the last of the large items of the lock operating and protective devices to be installed. The delivery of the chains, which are of unusual size and present many difficulties in manufacture, has been uncertain. Chains have been under order at three different American chain works simultaneously, and The Panama Canal is now inviting tenders from Europe for the remaining nine. The chains average from 418 to 434 ft. in length, and the two for protecting the lower guard gates at Miraflores Locks are each 784 ft. long, being specially arranged on account of the tidal fluctuation. They weigh about 85 lb. to the foot, nearly three times as much as the heaviest rails on the Panama R.R. The links are made from bars 3 in. in diameter, and each link in the principal part of the chain is 17 in. long by 10¾ in. wide. The chains are designed to withstand normally a tension of 220,000 lb., or approximately 100 gross tons, which is about 50% of their breaking load.—"Canal Record."

New York Town Awarded Contract for Highway Construction—A note in our construction news columns of June 18 recorded the award of the contract for constructing Road No. 1187 in Monroe County to the Town of Mendon for $20,141. The circumstances are explained as follows, by Royal K. Fuller, Secretary of the State Highway Commission:

The Town of Mendon submitted a proposal for the construction of highway No. 1187, under the provisions of Section 131 of the Highway Law. That section provides that the board of supervisors or the town board of a town in which any portion of a county highway is situated may present proposal and be awarded a contract for the construction or improvement of such highway for and on behalf of such county and town.

The Monroe County authorities were desirous of making the experiment of having a highway built by town authorities under the provisions of this law and the town board, with the assistance of J. Y. McClintock, M. Am. Soc. C. E., County Superintendent, submitted a bid on this work. The

gineer's estimate had been kept at a particularly low figure that it would not be likely that anyone would bid under price bid by the town.

Section 131 provides that if such contract be awarded the ard of supervisors or town board, such board shall by solution designate some suitable person or persons to carry to effect on behalf of the town such contract and transact business in respect thereto, as may be necessary. This tion has been taken in the case of the Town of Mendon nd bond has been given to the town guaranteeing the faithful performance of the contract. Under the provisions of the w, the board of supervisors and the town board will designate by resolution a banking corporation or a trust company wherein the moneys received on such contract will be deposited.

This system of building roads by the town has been tried n the past but has not been entirely successful; but it has never been demonstrated that the fault was with the system; on the contrary it was believed that it was entirely with the way the work was carried out.

Under a recent amendment of the Highway Law, any town can bid for a contract for state or county highway and if the contract is awarded, and it desires to do so, can make application to the Superintendent of Prisons for convict labor to work on the roads. In this case, the Town of Mendon is not going to do this but is going to do the work itself the same as any contractor would do.

PERSONALS

Mr. S. Hickson has been appointed Roadmaster of the Oregon-Washington R.R. & Navigation Co., at Colfax, Wash., succeeding Mr. T. Keaveny, resigned.

Mr. Charles J. Chenworth, Engineer of Roadway of the Atlantic Coast Line R.R., Savannah, Ga., has been appointed a member of the Board of Drainage Commissioners of Savannah.

Mr. C. M. Means, M. Am. Inst. E. E., Consulting Engineer, Randolph-Means Co., Pittsburgh, Penn., has been appointed Consulting Electrical Engineer of the United States Bureau of Mines.

Mr. N. P. Zech, recently in charge of statistics of the subsidiary companies of H. M. Byllesby & Co., Chicago, Ill., has been elected Comptroller of the Atlantic Gas & Electric Co., New York City.

Mr. Joseph S. Mallary has resigned as Fire Marshal of Philadelphia, Penn., to become Chief Engineer of the Merchant & Evans Co., of Philadelphia. He is succeeded as Fire Marshall by Mr. George W. Elliott, Deputy Fire Marshall.

Dr. Edgar Marburg, M. Am. Soc. C. E., Professor of civil engineering at the University of Pennsylvania, delivered the commencement address on June 11, and received the honorary degree of Doctor of Laws, at Franklin and Marshall College.

Prof. John H. Nelson, of the department of applied mechanics, Worcester Polytechnic Institute, has been granted six months' leave of absence, which he will spend as Associate Engineer-Physicist, United States Bureau of Standards, Washington, D. C.

Mr. George H. Wynn, of Canton, Ohio, has been appointed Resident Engineer in charge of construction of the new sewage-disposal plant at Canton. Mr. Wynn received the highest rating at the recent civil-service examinations. He was formerly with the engineering staffs of the American Bridge Co., Pittsburgh, Penn., and the Berger Co., of Canton.

Mr. William A. Williams, M. Am. Inst. M. E., recently Chief Geologist of the Associated Oil Co., San Francisco, Calif., has been appointed Chief Petroleum Engineer of the United States Bureau of Mines, San Francisco office. Mr. Williams is a graduate of Leland Stanford University, and has made a specialty of petroleum mining for the past 10 years.

Mr. J. H. Toupet has resigned as Chief Engineer of the National Fire Proofing Co., and has opened an office at 1428 Oliver Bldg., Pittsburgh, Penn., under the firm name of Toupet, Bell & Conley, Inc., Fireproofing Specialists and Contracting Engineers. Mr. Toupet is President, Mr. F. C. Bell, Treasurer and Mr. F. G. Conley, Secretary of the new firm.

Prof. R. L. Sackett, Assoc. M. Am. Soc. C. E., of Purdue University, Lafayette, Ind., has been appointed a member of a newly created State Highway Commission of Indiana. The other four commissioners appointed by the governor are Messrs. Thomas Taggart, of Indianapolis; W. H. O'Brien, of Lawrenceburg; Leonard B. Clore, of Laporte, and Addison C. Harris, of Indianapolis.

Mr. I. M. de Varona, M. Am. Soc. C. E., Chief Engineer of the Department of Water Supply, Gas and Electricity, New York City, has resigned. Mr. de Varona is 72 years old and has been in the city service for over 30 years. He will probably retire on a pension of half his salary of $10,000 per annum. Mr. de Varona graduated from Rensselaer Polytechnic Institute in 1863, and was first connected with the Brooklyn water-works as Assistant Engineer. Later he was Chief Engineer of the Brooklyn water-works.

Prof. Frederick G. Cottrell, M. Am. Inst. M. E., formerly of the University of California, Oakland, Calif., has been appointed Chief Chemist of the United States Bureau of Mines. Prof. Cottrell has been Chief Physical Chemist with the Bureau of Mines since 1911. He is a graduate of the Universities of California, Berlin and Leipsic, and is famous as the inventor of the process for electrical precipitation of suspended particles from smelter fumes, described in "Engineering News" of Oct. 26, 1911. In order to accept his position with the Bureau of Mines he gave to the Smithsonian Institution at Washington his patents on this and other valuable processes.

Mr. William McClellan, F. Am. Inst. E. E., Consulting Engineer, New York City, formerly Chief of the Division of Light, Heat and Power, Public Service Commission, Second District, New York, has been appointed "Confidental Engineer" in charge of the physical valuation and investigation of the New York Telephone Co. The chairman of the Public Service Commission is reported to have said that he would ask the commission to place all appointments to be made in connection with this work under the exempt class. Mr. McClellan was born in Philadelphia, Penn., in 1872, and graduated from the University of Pennsylvania in 1900. From 1905 to 1907 he was with Westinghouse, Church, Kerr & Co., New York City.

Dr. William David Coolidge, Assoc. Am. Inst. E. E., Assistant Director of the Research Laboratory, General Electric Co., Schenectady, N. Y., has been awarded the Rumford Medal of the American Academy of Arts and Sciences for his invention of ductile tungsten and its application in electric illumination. Dr. Coolidge was born in Hudson, Mass., and graduated at the Massachusetts Institute of Technology in 1896. He received his roctor's degree at the University of Leipsic in 1899. Until 1905 he was a member of the faculty of the Institute. He was appointed Assistant Director of the Research Laboratory of the General Electric Co. in 1908. Some of the other recipients of the Rumford Medal have been Ericsson, Langley, Edison, Curtis and others.

Mr. W. Averill Harriman has been elected Vice-President of the Union Pacific Ry., to succeed Mr. W. V. S. Thorne, resigned. Mr. Harriman is 24 years old and has had no very extensive railway operating experience. He is, however, the son of the late Edward H. Harriman. Mr. Thorne is a graduate of Sheffield Scientific School, Yale University, and has been in railway work since January, 1886, when he joined the engineering staff of the St. Paul, Minneapolis & Manitoba Ry., on preliminary surveys and construction. He was subsequently promoted to be Superintendent of the Minnesota division of the Great Northern Ry., and was later an executive officer of other railways. He became connected with the Union Pacific Ry. in 1902 as Assistant to the President, E. H. Harriman, and has since been in charge of the purchasing department. Mr. Harriman is reported to have spent part of his summer vacations working as a chainman of a survey party, as a fireman on a locomotive and as a clerk in the freight department of the Union Pacific Ry.

OBITUARY

Russell S. Penniman, former General Manager of the West Coast Division of the E. I. du Pont de Nemours Powder Co., died June 18, at his home in San Francisco, Calif.

Newton Wilson, M. Am. Inst. M. E., of Beaumont, Tex., died in St. Louis, Mo., June 23. He was 56 years old and widely known throughout the Southwest and Mexico.

Edmund C. Limbach, M. Am. Inst. M. E., was accidentally killed in a mine at Oglesby, Calif., June 16. He was 42 years old and a graduate of the Colorado School of Mines, class of 1894.

Morgan Bransby Williams, M. Inst. C. E., in early life connected with the construction of some of the most important railways in England, died in London, June 22, aged 89 years. For the past 20 years he had been a banker of prominence. He was born in 1825. After a grammar-school education he started his career in mining engineering, but subsequently turned to civil engineering and railway construction. He was employed on the construction of the London & Northwestern Ry., the Caledonian Ry. and the London & Southwestern Ry. He then went to Italy, where he was Engineer of Construction on numerous railway lines, and later to Russia, where he was Chief Resident Engineer for the late Sir

John Hawshaw. While in Russia he married the Baroness von Wulf, daughter of the Military Governor of St. Petersburg. For some time Mr. Williams was General Manager of the Dünaburg & Witepsk Ry. in Russia, until it was purchased by the Russian Government. He then retired from engineering and railway work and made his home in South Wales.

Mrs. George Westinghouse died at her country residence, Erskine Park, Lenox, Mass., on June 23. Mrs. Westinghouse had been in ill health since September, 1912, when she suffered partial paralysis. Since the death of Mr. Westinghouse, in March last, her condition has been serious. Mrs. Westinghouse was the daughter of Capt. Daniel Walker, of Roxbury, Delaware County, N. Y. She was married to Mr. Westinghouse in Brooklyn, N. Y., Aug. 8, 1867, when he was a young and comparatively unknown inventor. Mrs. Westinghouse was prominent in social matters and in charity work, and took a great interest in Mr. Westinghouse's engineering activities. When the American Society of Mechanical Engineers held its Washington meeting in May, 1899, Mrs. Westinghouse gave a special reception in her Washington residence to the Society, building a special pavilion on the lawn adjacent to the house in order to accommodate the large number of guests. In later years she had been present with Mr. Westinghouse at many of the Society's social affairs and had become well known to many of the members.

Benezette Williams, Consulting Engineer, of Chicago, died at Western Springs, Ill., June 22. His residence was at that place and he was about to start to attend the commencement exercises at the University of Michigan, where he was to receive an honorary degree of Master of Engineering. He fell dead in the railway station. He was born at West Liberty, Ohio, Nov. 9, 1844. He graduated from the University of Michigan in 1869, and the same year went to Chicago, where he entered the office of E. S. Chesbrough, civil engineer. Later he was in the office of the city engineer of Milwaukee, and then in railway service on the Milwaukee, Lake Shore & Western Ry. and Chicago, Burlington & Quincy R.R. In 1872 he became Assistant Engineer for Mr. Chesbrough, then City Engineer of Chicago; he worked in the sewer and waterworks departments, was in charge of the construction of the Fullerton Ave. conduit, and later became Superintendent of Sewers. He was City Engineer of Chicago from 1875 to 1879. He took a prominent part in the preliminary projects and the early construction of the Chicago drainage canal, and was Chief Engineer of the Sanitary District of Chicago (which is in charge of the canal) in 1892 and 1893. Afterward he took up private practice, maintaining an office in Chicago and making a specialty of municipal and sanitary engineering. He was a member of a commission appointed some years ago to report on an improved water-supply for St. Louis, Mo. He became a member of the Western Society of Engineers in 1872, and was president of the Society in 1880. He was married to Lydia J. Terrell, at Cleveland, Ohio, in 1871, and had three sons and a daughter.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 30-July 3. Seventeenth annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

AMERICAN SOCIETY OF ENGINEERS, ARCHITECTS AND CONSTRUCTORS.
July 3-4. Convention at Brighton Beach, L. I. Secretary, T. Hugh Boorman, 35 W. 39th St., New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
July 9-11. Semi-annual meeting at Cleveland, Ohio. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 16-19. Annual convention at Cedar Point, Ohio. Secy., D. L. Gasgill, Greenville, Ohio.

AMERICAN ASSOCIATION OF RAILROAD SUPERINTENDENTS.
Aug. 20-21. Annual meeting in New York City. Secy., E. H. Harman, Room 101, Union Station, St. Louis, Mo.

AMERICAN PEAT SOCIETY.
Aug. 20-22. Annual meeting at Duluth, Minn. Secy., Julius Bordollo, 17 Battery Place, New York City.

Inland Waterways Association—Steps were taken on June 19 to organize a section of the Inland Waterways Association in the Sacramento Valley, California.

Pittsburgh Chapter of the Illuminating Engineers' Society—At the annual meeting of the Chapter held at the Schenley Hotel, June 19, G. W. Rosa was elected Chairman and F. H. Gibbons, Secretary.

Railway Signal Association—The next annual convention will be held Sept. 22-24, at Bluff Point, N. Y., with headquarters at the Hotel Champlain. The secretary is C. C. Rosenberg, Times Building, Bethlehem, Penn.

Illuminating Engineering Society—The eighth annual convention will be held Sept. 21-25 in Cleveland, Ohio. The assistant secretary is Joseph Langan, 29 West 39th St., New York City.

Fourth American Road Congress—The Congress under the auspices of the American Highway Association, and the American Automobile Association, will be held in Atlanta, Ga., Nov. 9-14. Inquiries should be addressed to Colorado Bldg., Washington, D. C.

Portland Association of Members of the American Society of Civil Engineers—At a regular meeting of the Association held in Portland on June 5, Frederick W. Mulkey, Chairman of the Commission of Public Docks, spoke on the Portland Harbor and Docks.

American Society of Agricultural Engineers—The next meeting of the Society, whose membership has grown 25% since Jan. 1, will be held in Chicago, Dec. 28-30. One of the items for discussion is whether to hold an extra meeting in San Francisco during the Panama-Pacific exposition. The secretary is F. M. White, Madison, Wis.

Southwestern Water-Works Association—At the annual convention held at Tulsa, Okla., June 15-17, the following officers were elected: President, H. L. McDuffie, Sherman Okla.; Vice-Presidents, Jesse Shaw, Topeka, Kan., and W. H. Bruce, Fort Smith, Ark., R. E. McDonnell, Kansas City, Mo., L. H. Gray, Lufkin, Tex., and J. B. Hudgins, Roswell, N. M.; Secretary-Treasurer E. L. Fulkerson, Waco, Tex. The 1915 convention will be held at Galveston, Tex.

National Association of Sheet-Metal Contractors—About 600 delegates attended the 10th annual convention of the Association, held in Cincinnati, Ohio, June 16-19. The next annual convention will be held in Denver, Colo. The officers elected for the ensuing year were, President, Paul F. Brandsted, Washington, D. C.; Vice-Presidents, Julius Gerock, St. Louis, Mo., K. I. Willis, Moline, Ill., and T. P. Walsh, of Youngstown, Ohio; Treasurer, W. A. Fingles, Baltimore, Md.; Secretary, Edwin L. Seabrook, Philadelphia, Penn.

Sixth International Congress of the Mining, Metallurgy, Engineering and Economic Geology—The Sixth Congress will be held in London, July 12-17, 1915, and will be divided into four sections: Mining, metallurgy, engineering and economic geology. Among the subjects to be treated in the engineering section are the following: Exhaust-steam turbines; gas motors and turbines; compressed-air locomotives in mines; economics of rock drilling; standards of comparison in the use of compressed air; utilization of low-grade fuel. Inquiries should be addressed to the Secretary of the International Congress, 28 Pretoria St., London, S. W.

The Pacific Northwest Society of Engineers—The 12th annual convention of the Society was held in Seattle June 19-20. President Joseph Jacobs, in his annual address, made a plea for the opening up of the arid and logged-off lands of the Pacific Northwest. In speaking of the opening of the Panama Canal, he said: "Of the 300,000 to 600,000 immigrants likely to come to the Pacific Coast, Washington will get at least 40,000, and if only five acres per capita were allowed, it would total 200,000 acres; figuring $50 per acre as cost of reclamation, the expenditure would be $10,000,000." In the afternoon session a paper was delivered by Floyd W. Allen, Deputy Engineer of King County, on "Highway Construction." In the evening the annual banquet was held at the Hotel Frye. Sterling B. Hill acted as toastmaster, and the principal address of the evening was delivered by D. C. Henny, Consulting Engineer of the United States Reclamation Service, who spoke on "Storage Problems in the Yakima Valley."

New England Water Works Association—The June outing of the association, held in Worcester, Mass., June 24, was a very enjoyable affair. After the arrival of the main party from Boston at 9:45 a.m., automobiles and a special trolley car were taken to the town of Holden, where the new reservoirs of the Worcester water supply were inspected. At Pine Hill the city has begun the construction of a 60-ft. masonry dam on one of the most remarkable dam sites in the Eastern States. The valley is narrow, with a granite ridge running part way across. From Pine Hill the party proceeded to the Tatassit Canoe Club House on an island in Lake Quinsigamond, where a lunch was served. Mayor Wright, of Worcester was an invited guest. In the afternoon the party went to the northern outskirts of the city to witness the operation of a municipally owned Austin trenching machine. Afterward an inspection was made of the city water-works shops and stable.